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Screening Level Ecological Risk Assessment

Screening Level Ecological Risk Assessment for the INEEL CERCLA Disposal Facility Complex

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INEEL
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CONTENTS

FIGURES

TABLES

ACRONYMS

ADE	average decay energy
AF	adjustment factor
ALC	acceptable leachate concentration
BAF	bioaccumulation factor
BDAC	Biotic Dose Assessment Committee
BCG	Biotic Concentration Guide
BW	body weight
CERCLA	Comprehensive Environmental Response and Compensation Liability Act
CF	concentration factor
COPC	contaminant of potential concern
CS	concentration of contaminant in soil
CSM	conceptual site model
CV	concentration of contaminant in vegetation
CWID	CERCLA Waste Inventory Database
DOE	Department of Energy
EBSL	ecologically based screening level
ED	exposure duration
EDF	Engineering Design File
ERA	ecological risk assessment
FA	fraction of decay energy absorbed
HI	hazard index
HQ	hazard quotient
ICDF	INEEL CERCLA Disposal Facility
INEEL	Idaho National Engineering and Environmental Laboratory
INTEC	Idaho Nuclear Technology and Engineering Center

IR	ingestion rate
OU	operable unit
PP	percent prey
PS	percent soil
PUF	plant uptake factor
PV	percent vegetation
QCEL	quantified critical exposure level
RESL	Radiological and Environmental Sciences Laboratory
RI/FS	remedial investigation/feasibility study
ROD	Record of Decision
SDA	Subsurface Disposal Area
SLERA	screening level ecological risk assessment
SLQ	screening level quotient
SSSTF	Staging, Storage, Sizing, and Treatment Facility
SUF	site usage factor
TCC	Typic-Camborthids-Typic Calciorthids
T/E	threatened and endangered
THQ	total hazard quotient
TRV	toxicity reference value
TSLQ	total screening level quotient
TTF	Typic Torrifluvents
WAG	waste area group
WI	water ingestion

Screening Level Ecological Risk Assessment for the INEEL CERCLA Disposal Facility Complex

The objective of this assessment is to determine the potential for adverse effects on ecological receptor populations, including protected wildlife species, as a result of exposure to the INEEL CERCLA Disposal Facility (ICDF) Complex. Figure 1 shows the location of INTEC within the Idaho National Engineering and Environmental Laboratory (INEEL). The U.S. Department of Energy (DOE) authorized a remedial design/remedial action of the INEEL including INTEC in accordance with the Waste Area Group (WAG) 3 Operable Unit (OU) 3-13 Record of Decision (ROD). The ROD requires contaminated surface soil be removed and disposed of on-Site in the ICDF. The ICDF Complex layout and location relative to the Idaho Nuclear Technology and Engineering Center (INTEC) is presented in Figure 2.

The major components of the ICDF are the disposal cells (landfill), an evaporation pond, and the Staging, Storage, Sizing, and Treatment Facility (SSSTF) (DOE-ID 2002). The disposal cells, including the buffer zone, will cover approximately 40 acres. The evaporation pond is composed of two individual cells with sufficient capacity for landfill leachate, precipitation directly into the pond, and additional inflows (i.e., washdown water for trucks and equipment, and purge/development water) (EDF-ER-271). The evaporation pond area, with a bottom area of 88,000 ft^2 and a depth of 64 inches, is designed to handle the worst-case conditions. Raw make-up water will be used to keep pond sediments submerged over the evaporation surface area allowed and the assumed pond inflow conditions (EDF-ER-271). The SSSTF will be a building designed to provide centralized receiving, inspection, and treatment necessary to stage, store, and treat incoming waste. This screening level ecological risk assessment (SLERA) addresses risk from modeled concentrations in both the disposal cells (landfill) and the evaporation pond.

The ICDF Complex will be a highly disturbed area during the construction and disposal of the contaminated soil. The disturbed layer will discourage most mammalian species from reaching or burrowing into the contaminated soil, and avian species exposure will be nearly eliminated. The ICDF complex will be fenced. While this will not eliminate all species from using the area, it will provide another deterrent to exposure.

The addition of the 10-foot biobarrier when the facility is ultimately closed should eliminate exposure to ecological receptors. None of the mammalian and plant species identified in the Subsurface Disposal Area (SDA) Biotic Data Compilation (EDF-ER-WAG7-76, which deals with the maximum burrowing depths of mammals and rooting depth of plants for species found at the INEEL), burrowed or had rooting depths exceeding the 10-foot depth the biobarrier will provide.

The evaporation pond will also be constructed to minimize exposure to receptors. The pond area and depth were determined based on the need to evaporate all ICDF landfill leachate, precipitation falling directly on the ponds, and additional flows totaling 30,000 gallons per month from March through November of each year from such sources as washdown water for trucks and equipment and purge/development water. The evaporative surface area was selected to allow evaporation of the average leachate production and precipitation onto the pond. Then the pond depth was selected to provide storage for excess leachate and precipitation that may accumulate if the worst-case leachate and precipitation were to occur for 3 years in a row following an average year.

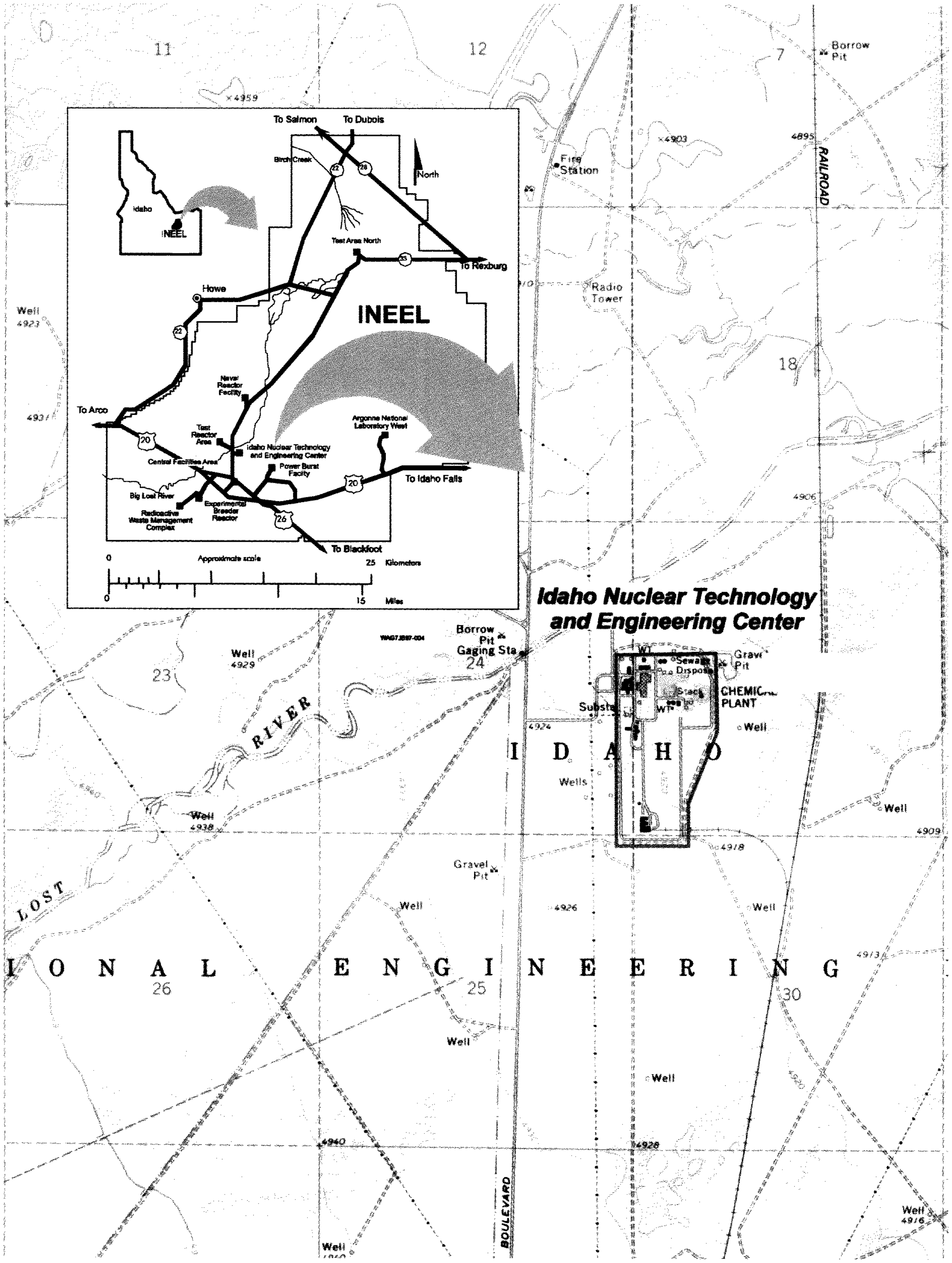

Figure 1. Location of INTEC within the INEEL.

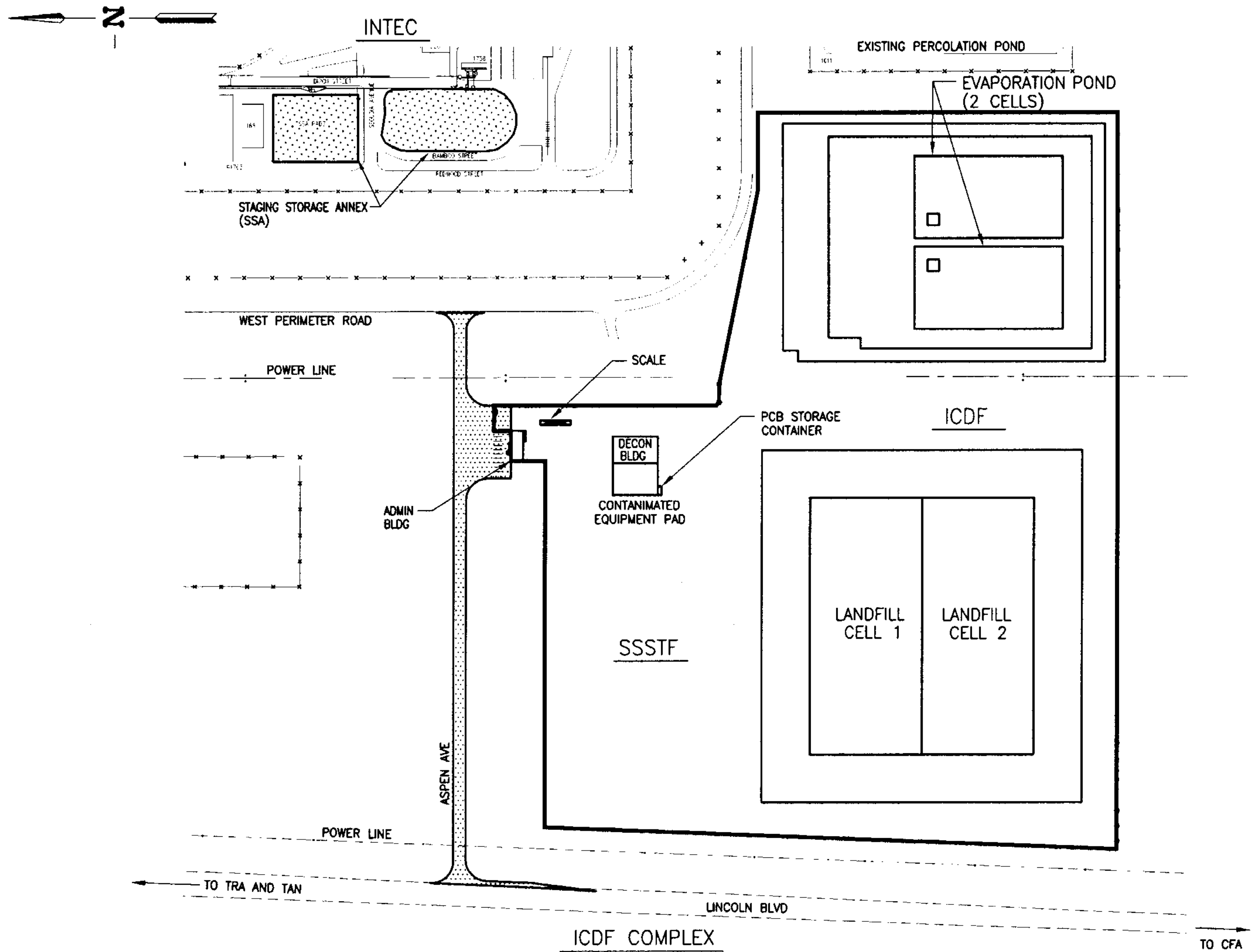

Figure 2. ICDF Complex layout and location relative to INTEC.

The results of the computations showed that a total evaporation pond area bottom area of 88,000 ft^2 with depth of 64 in. will be adequate to handle the worst-case conditions. This depth provides a minimum freeboard of 24 in. Raw make-up water necessary to keep pond sediments submerged was found to be between 1 and 6 gallons per minute (gpm) over a period ranging from 3 to 6 months, depending upon the evaporation surface area allowed and the assumed pond inflow conditions (EDF-ER-271).

The evaporation ponds are double lined as described in Draft Evaporation Pond Lining System Equivalency Analysis (EDF-ER-312). A fence will be constructed to minimize access to the pond by receptors and the sides will be maintained to minimize vegetation and habitat. In the INEEL site environment, any waterbody will be used by migrating waterfowl. Studies of the use of the TRA warm waste ponds indicate that although the pond will be used by migrating waterfowl, this use is expected to be minimal and the exposure to the receptor is expected to be 27 hours on average[a] (the receptor will continue its migration and not become a permanent resident at the pond). However, exposure to waterfowl was assessed in Appendix A and discussed in Section 6.

1. METHODS

The assessment was performed using the same basic methodology developed in the *Guidance Manual for Conducting Screening Level Ecological Risk Assessments at the INEL* (VanHorn, Hampton, and Morris 1995), subsequently referred to as the Guidance Manual. This methodology has been applied in INEEL ecological risk assessments (ERAs) for various WAGs, particularly those included in the WAG 3 Comprehensive RI/BRA and RI/FS (DOE-ID 1997, DOE-ID 1998). The methodology was specifically designed to follow the direction provided by the *Framework for Ecological Risk Assessment* (EPA 1992) and more recent EPA guidelines (EPA 1996a). This framework divides this SLERA process into three steps: problem formulation, analysis, and risk characterization.

In the problem formulation step, the interactions between the stressor characteristics, the ecosystem potentially at risk, and the ecological effects were defined (EPA 1992). Problem formulation results in characterization of stressors (i.e., identification of the contaminants, and their extents and concentrations), definition of assessment and measurement endpoints, and construction of the conceptual site model (CSM).

In the analysis step, the likelihood and significance of an adverse reaction from exposure to the stressor(s) were evaluated. The behavior and fate of the contaminants of potential concern (COPCs) in the terrestrial environment was presented in a general manner because no formal fate and transport modeling was conducted for this assessment. The ecological effects assessment includes a hazard evaluation and dose-response assessment, including a comprehensive review of toxicity data for contaminants to identify the nature and severity of toxic properties. Doses from subsurface contamination of the ICDF were developed and used to assess potential risk to receptors. Because no dose-based toxicological criteria exist for ecological receptors, it was necessary to choose appropriate toxicity reference values (TRVs) for the contaminants and apply them to functional groups at INEEL. A quantitative analysis was used, augmented by qualitative information and professional judgment.

The risk characterization step included two primary elements (EPA 1992). The first element is the development of an indication of the likelihood of adverse effects to ecological receptors. The second element is the presentation of the assessment results in a form that serves as input to the risk management

a. Warren, W. W., S. J. Majors, and R. C. Morris, 2001, "Waterfowl Uptake of Radionuclides from the TRA Evaporation Ponds and Potential Dose to Humans Consuming Them (Draft)," for the Department of Energy, Idaho Operations Office, February 2001.

process. To determine whether there is any indication of risk due to the modeled contaminant concentrations, a screening against INEEL-specific ecologically based screening levels (EBSLs) was included. Exceeding an EBSL concentration was considered an indicator of potential adverse effects.

1.1 Problem Formulation

Primary elements of the problem formulation step for the SLERA are described in the following sections. The problem formulation includes the definition of contaminant extents and concentrations (Section 1.1.1), characterization of the ecosystem (Section 1.1.2), identification of COPCs initially screened for subsequent quantitative evaluation (Section 1.1.3), definition of assessment endpoints and presentation of the CSM (Section 1.1.4).

1.1.1 Contamination Extent and Concentration

The major components of the ICDF Complex are the two landfill disposal cells, an evaporation pond with two cells, staging and storage areas, the decontamination facility, and the treatment facility. The landfill disposal cells are primarily for soils and other solid wastes and the evaporation ponds are for aqueous wastes. The SSSTF is designed to provide centralized receiving, staging, storage, packaging, and treatment from various INEEL Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) remediation/removal and investigation sites prior to disposal in the ICDF landfill, the evaporation pond, or shipment off-Site. A major factor in the design of the ICDF landfill and the evaporation pond was the inventory of organic inorganic, and radionuclide contaminants (type, mass, and concentration) that will be disposed.

The IDCF Design Inventory (EDF-ER-264) contains the inventory of organic, inorganic and radionuclide contaminants (type, mass, and concentration) that will be deposited. This engineering design file (EDF) identifies a preliminary waste inventory that was used to assist in the design basis of the ICDF landfill and the evaporation pond. The design inventory is based primarily on the analytical data contained in the Design Inventory (EDF-ER-264) and in part on information in the CERCLA Waste Inventory Database (CWID), which is described in DOE-ID (2000) (referred to as the CWID Report). Very conservative assumptions were made in these reports to provide an upper bound to ensure adequate facility design. Therefore, all data having detectable concentrations were used in development of the design inventory. For radionuclides, the concentrations in the design inventory were decayed to a common date of January 1, 2002. The design inventory for the ICDF includes waste from the remediation sites that have been identified in the Design Inventory EDF for disposal in the ICDF landfill. A total of 413,000 yd^3 (315,700 m^3) of contaminated soil and debris from 36 release sites has been identified for disposal in the ICDF landfill during its first 10 years of operation.

The Design Inventory EDF states that because much of the design inventory is conservatively estimated, it should not be used to approximate actual site conditions. However, it does provide an initial approximation of the wastes that may be disposed of in the ICDF landfill and it was used for the evaluation of the landfill in this risk assessment.

As discussed in the contaminant screening section, initial screening concentrations were based on the maximum contaminant masses and activities presented in the Design Inventory (EDF-ER-264).

The modeled contaminant masses (in mg) or activity (in pCi) were divided by the entire volume capacity of the ICDF landfill (389,000 m^3) to yield the concentration (mg/kg or pCi/g) assumed throughout the entire landfill used in the risk assessment. The expected ICDF inventories and maximum concentrations (concentrations development can be found in later sections) for organic, inorganic, and radiological contaminants can be found in Tables 1–3.

Table 1. Maximum contaminant masses and calculated concentrations for organics identified in the EDF-ER-264. (No organic leachates were identified in EDF-ER-274.)

Contaminant	Maximum Contaminant Mass (kg) from EDF-ER-264	Maximum Concentration (mg/kg) Calculated from EDF-ER-264
1,1,1-Trichloroethane	7.40E+00	1.27E-02
1,1,2,2-Tetrachloroethane	2.30E-02	3.94E-05
1,1,2-Trichloroethane	1.10E-01	1.89E-04
1,1-Dichloroethane	1.10E+00	1.89E-03
1,1-Dichloroethene	7.00E-01	1.20E-03
1,2,4-Trichlorobenzene	5.40E+00	9.26E-03
1,2-Dichlorobenzene	5.40E+00	9.26E-03
1,2-Dichloroethane	2.50E-03	4.29E-06
1,2-Dichloroethene (total)	1.50E-01	2.57E-04
1,3-Dichlorobenzene	5.40E+00	9.26E-03
1,4-Dichlorobenzene	2.10E+02	3.60E-01
1,4-Dioxane	8.90E-03	1.53E-05
2,4,5-Trichlorophenol	2.10E+01	3.60E-02
2,4,6-Trichlorophenol	8.60E+00	1.47E-02
2,4-Dichlorophenol	1.00E+01	1.71E-02
2,4-Dimethylphenol	8.60E+00	1.47E-02
2,4-Dinitrophenol	2.40E+01	4.12E-02
2,4-Dinitrotoluene	5.40E+00	9.26E-03
2,6-Dinitrotoluene	9.80E+00	1.68E-02
2-Butanone	1.20E+01	2.06E-02
2-Chloronaphthalene	5.40E+00	9.26E-03
2-Chlorophenol	8.60E+00	1.47E-02
2-Hexanone	1.30E+00	2.23E-03
2-Methylnaphthalene	2.40E+02	4.12E-01
2-Methylphenol	9.80E+00	1.68E-02
2-Nitroaniline	1.30E+01	2.23E-02
2-Nitrophenol	8.60E+00	1.47E-02
3,3'-Dichlorobenzidine	5.40E+00	9.26E-03
3-Methyl Butanal	1.10E-01	1.89E-04
3-Nitroaniline	1.30E+01	2.23E-02

Table 1. (continued).

Contaminant	Maximum Contaminant Mass (kg) from EDF-ER-264	Maximum Concentration (mg/kg) Calculated from EDF-ER-264
4,6-Dinitro-2-methylphenol	2.10E+01	3.60E-02
4-Bromophenyl-phenylether	5.40E+00	9.26E-03
4-Chloro-3-methylphenol	8.60E+00	1.47E-02
4-Chloroaniline	1.90E+01	3.26E-02
4-Chlorophenyl-phenylether	5.40E+00	9.26E-03
4-Methyl-2-Pentanone	1.40E+01	2.40E-02
4-Methylphenol	1.80E+01	3.09E-02
4-Nitroaniline	1.30E+01	2.23E-02
4-Nitrophenol	2.40E+01	4.12E-02
Acenaphthene	9.60E+01	1.65E-01
Acenaphthylene	9.80E+00	1.68E-02
Acetone	2.90E+02	4.97E-01
Acetonitrile	8.90E-03	1.53E-05
Acrolein	4.30E-03	7.37E-06
Acrylonitrile	4.30E-03	7.37E-06
Anthracene	1.50E+02	2.57E-01
Aramite	5.40E-02	9.26E-05
Aroclor-1016	3.60E+00	6.17E-03
Aroclor-1254	6.10E+01	1.05E-01
Aroclor-1260	3.40E+02	5.83E-01
Aroclor-1268	2.90E+01	4.97E-02
Benzene	2.90E+02	4.97E-01
Benzidine	1.40E-01	2.40E-04
Benzo(a)anthracene	1.20E+02	2.06E-01
Benzo(a)pyrene	5.00E+01	8.57E-02
Benzo(b)fluoranthene	8.50E+01	1.46E-01
Benzo(g,h,i)perylene	5.40E+00	9.26E-03
Benzo(k)fluoranthene	8.80E+00	1.51E-02
Benzoic acid	4.10E+00	7.03E-03
bis(2-Chloroethoxy)methane	5.40E+00	9.26E-03
bis(2-Chloroethyl)ether	5.40E+00	9.26E-03
bis(2-Chloroisopropyl)ether	5.40E+00	9.26E-03

Table 1. (continued).

Contaminant	Maximum Contaminant Mass (kg) from EDF-ER-264	Maximum Concentration (mg/kg) Calculated from EDF-ER-264
bis(2-Ethylhexyl)phthalate	7.00E+01	1.20E-01
Butane,1,1,3,4-Tetrachloro-	3.70E+00	6.34E-03
Butylbenzylphthalate	3.20E+01	5.49E-02
Carbazole	1.50E+01	2.57E-02
Carbon Disulfide	2.20E+01	3.77E-02
Chlorobenzene	3.10E+00	5.32E-03
Chloroethane	1.40E-03	2.40E-06
Chloromethane	1.70E-01	2.91E-04
Chrysene	1.30E+02	2.23E-01
Decane, 3,4-Dimethyl	7.60E-02	1.30E-04
Diacetone alcohol	2.00E+03	3.43E+00
Dibenz(a,h)anthracene	5.40E+00	9.26E-03
Dibenzofuran	1.50E+02	2.57E-01
Diethylphthalate	5.40E+00	9.26E-03
Dimethyl Disulfide	1.40E+00	2.40E-03
Dimethylphthalate	5.40E+00	9.26E-03
Di-n-butylphthalate	1.10E+01	1.89E-02
Di-n-octylphthalate	1.20E+01	2.06E-02
Eicosane	1.30E+00	2.23E-03
Ethyl cyanide	8.90E-03	1.53E-05
Ethylbenzene	3.70E+01	6.34E-02
Famphur	2.80E-02	4.80E-05
Fluoranthene	3.60E+02	6.17E-01
Fluorene	8.70E+01	1.49E-01
Heptadecane, 2,6,10,15-Tetra	1.60E+00	2.74E-03
Hexachlorobenzene	5.40E+00	9.26E-03
Hexachlorobutadiene	9.80E+00	1.68E-02
Hexachlorocyclopentadiene	5.40E+00	9.26E-03
Hexachloroethane	5.40E+00	9.26E-03
Indeno(1,2,3-cd)pyrene	5.40E+00	9.26E-03
Isobutyl alcohol	8.90E-03	1.53E-05
Isophorone	5.40E+00	9.26E-03

Table 1. (continued).

Contaminant	Maximum Contaminant Mass (kg) from EDF-ER-264	Maximum Concentration (mg/kg) Calculated from EDF-ER-264
Isopropyl Alcohol/2-propanol	1.00E+00	1.71E-03
Kepone	4.70E+01	8.06E-02
Mesityl oxide	4.00E+01	6.86E-02
Methyl Acetate	2.30E-01	3.94E-04
Methylene Chloride	4.00E+01	6.86E-02
Naphthalene	2.00E+02	3.43E-01
Nitrobenzene	5.40E+00	9.26E-03
N-Nitroso-di-n-propylamine	5.40E+00	9.26E-03
N-Nitrosodiphenylamine	5.40E+00	9.26E-03
Octane,2,3,7-Trimethyl	7.60E-02	1.30E-04
o-Toluenesulfonamide	2.40E+00	4.12E-03
Pentachlorophenol	2.60E+01	4.46E-02
Phenanthrene	5.50E+02	9.43E-01
Phenol	3.80E+01	6.52E-02
Phenol,2,6-Bis(1,1-Dimethyl)	1.90E+00	3.26E-03
p-Toluenesulfonamide	2.40E+00	4.12E-03
Pyrene	1.20E+02	2.06E-01
Styrene	4.90E-04	8.40E-07
Tetrachloroethene	4.60E+00	7.89E-03
Toluene	4.70E+02	8.06E-01
Tributylphosphate	1.70E+02	2.91E-01
Trichloroethene	3.40E+01	5.83E-02
Undecane,4,6-Dimethyl-	7.60E-02	1.30E-04
Xylene (ortho)	1.80E+00	3.09E-03
Xylene (total)	1.60E+03	2.74E+00

Table 2. Maximum contaminant masses and calculated concentrations for inorganics identified in the EDF-ER-264 (and leachates concentrations identified in EDF-ER-274).

	Maximum Contaminant Mass (kg) from EDF-ER-264	Maximum Concentration (mg/kg) Calculated from EDF-ER-264	Concentration (mg/L) Summed Over 15-Year Operational Period from EDF-ER-274
Aluminum	3.40E+06	5.83E+03	NA[a]
Antimony	2.80E+03	4.80E+00	NA
Arsenic	2.70E+03	4.63E+00	2.45E+01
Barium	8.50E+04	1.46E+02	NA
Beryllium	1.40E+02	2.40E-01	NA
Boron	8.70E+04	1.49E+02	6.50E+02
Cadmium	1.70E+03	2.91E+00	NA
Calcium	9.70E+06	1.66E+04	7.78E+01
Chloride	8.80E+02	1.51E+00	2.65E+02
Chromium III	1.90E+04	3.26E+01	NA
Cobalt	2.90E+03	4.97E+00	NA
Copper	1.40E+04	2.40E+01	NA
Cyanide	1.60E+02	2.74E-01	NA
Dysprosium	2.80E+04	4.80E+01	NA
Fluoride	1.80E+03	3.09E+00	As fluorine
Iron	4.90E+06	8.40E+03	NA
Lead	2.70E+04	4.63E+01	NA
Magnesium	2.10E+06	3.60E+03	NA
Manganese	9.80E+04	1.68E+02	4.00E+00
Mercury (inorganic)	4.50E+03	7.72E+00	NA
Molybdenum	4.80E+03	8.23E+00	NA
Nickel	9.30E+03	1.59E+01	NA
Nitrate	1.90E+03	3.26E+00	4.68E+02
Nitrate/Nitrite-N	1.10E+02	1.89E-01	NA
Nitrite	4.00E+00	6.86E-03	NA
Phosphorus	4.60E+04	7.89E+01	6.80E+00
Potassium	5.30E+05	9.09E+02	1.42E+00
Selenium	4.00E+02	6.86E-01	1.71E+00
Silver	4.70E+03	8.06E+00	NA
Sodium	1.00E+05	1.71E+02	NA

Table 2. (continued).

	Maximum Contaminant Mass (kg) from EDF-ER-264	Maximum Concentration (mg/kg) Calculated from EDF-ER-264	Concentration (mg/L) Summed Over 15-Year Operational Period from EDF-ER-274
Strontium	8.60E+03	1.47E+01	NA
Sulfate	9.70E+03	1.66E+01	5.97E+03
Sulfide	3.60E+05	6.17E+02	NA
Terbium	2.70E+05	4.63E+02	NA
Thallium	1.80E+02	3.09E-01	NA
Vanadium	1.00E+04	1.71E+01	5.56E+01
Ytterbium	9.20E+04	1.58E+02	NA
Zinc	9.90E+04	1.70E+02	5.00E-01
Zirconium	3.30E+04	5.66E+01	NA

a. NA indicates a leachate concentration was not calculated for this COPC.

Table 3. Maximum contaminant activity and calculated concentrations for radionuclides identified in the EDF-ER-264 (and leachates concentrations identified in EDF-ER-274).

	Half-Life in Years	Activity (Ci) from EDF-ER-264[a]	Maximum Concentration (pCi/g) Calculated from EDF-ER-264	Concentration (pCi/L) Summed Over 15-Year Operational Period from EDF-ER-274[b]
Ac-225	2.74E-02	2.40E-08	4.11E-08	NA[c]
Ac-227	2.18E+01	9.70E-06	1.66E-05	NA
Ac-228	6.99E-04	7.20E-11	1.23E-10	NA
Ag-108	4.51E-06	1.80E-09	3.08E-09	NA
Ag-108m	1.27E+02	3.80E-01	6.51E-01	NA
Ag-109m	1.25E-06	2.30E-12	3.94E-12	NA
Ag-110	7.79E-07	2.50E-11	4.28E-11	NA
Ag-110m	6.84E-01	2.60E-09	4.45E-09	NA
Am-241	4.32E+02	1.10E+01	1.88E+01	NA
Am-242	1.83E-03	2.10E-05	3.60E-05	NA
Am-242m	1.52E+02	2.10E-05	3.60E-05	NA
Am-243	7.38E+03	1.60E-04	2.74E-04	NA
Am-246	4.75E-05	6.50E-26	1.11E-25	NA
At-217	1.01E-09	2.40E-08	4.11E-08	NA
Ba-137m	4.85E-06	1.10E+04	1.88E+04	NA
Be-10	1.60E+06	5.40E-07	9.25E-07	NA
Bi-210	1.37E-02	5.20E-07	8.90E-07	NA
Bi-211	4.05E-06	8.70E-06	1.49E-05	NA
Bi-212	1.15E-04	2.60E-04	4.45E-04	NA
Bi-214	3.78E-05	2.70E-06	4.62E-06	NA
Bk-249	8.76E-01	1.00E-21	1.71E-21	NA
Bk-250	3.68E-04	3.70E-26	6.34E-26	NA
C-14	5.73E+03	2.20E-05	3.77E-05	NA
Cd-109	1.27E+00	2.30E-12	3.94E-12	NA
Cd-113m	1.37E+01	7.70E-01	1.32E+00	NA
Cd-115m	1.22E-01	2.00E-54	3.42E-54	NA
Ce-141	8.90E-02	8.50E-72	1.46E-71	NA
Ce-144	7.78E-01	8.60E-04	1.47E-03	NA
Cf-249	3.51E+02	2.00E-16	3.42E-16	NA

Table 3. (continued).

	Half-Life in Years	Activity (Ci) from EDF-ER-264[a]	Maximum Concentration (pCi/g) Calculated from EDF-ER-264	Concentration (pCi/L) Summed Over 15-Year Operational Period from EDF-ER-274[b]
Cf-250	1.31E+01	1.00E-16	1.71E-16	NA
Cf-251	9.00E+02	4.50E-19	7.71E-19	NA
Cf-252	2.64E+00	1.10E-20	1.88E-20	NA
Cm-241	9.58E-02	6.10E-81	1.04E-80	NA
Cm-242	4.47E-01	2.60E-17	4.45E-17	NA
Cm-243	2.85E+01	1.70E-06	2.91E-06	NA
Cm-244	1.81E+01	8.50E-04	1.46E-03	NA
Cm-245	8.50E+03	3.80E-08	6.51E-08	NA
Cm-246	4.75E+03	8.50E-10	1.46E-09	NA
Cm-247	1.56E+07	3.00E-16	5.14E-16	NA
Cm-248	3.39E+05	9.30E-17	1.59E-16	NA
Cm-250	6.90E+03	2.60E-25	4.45E-25	NA
Co-57	7.42E-01	1.70E-03	2.91E-03	NA
Co-58	1.94E-01	2.80E-17	4.79E-17	NA
Co-60	5.27E+00	9.20E+01	1.58E+02	NA
Cr-51	7.39E-02	1.10E-54	1.88E-54	NA
Cs-134	2.06E+00	5.30E+00	9.08E+00	NA
Cs-135	2.30E+06	1.70E-02	2.91E-02	NA
Cs-137	3.02E+01	1.20E+04	2.05E+04	NA
Eu-150	5.00E+00	8.20E-09	1.40E-08	NA
Eu-152	1.36E+01	4.60E+02	7.88E+02	NA
Eu-154	8.80E+00	3.90E+02	6.68E+02	NA
Eu-155	4.96E+00	8.40E+01	1.44E+02	NA
Fe-59	1.22E-01	2.10E-35	3.60E-35	NA
Fr-221	9.13E-06	2.40E-08	4.11E-08	NA
Fr-223	4.14E-05	1.30E-07	2.23E-07	NA
Gd-152	1.10E+14	1.30E-14	2.23E-14	NA
Gd-153	6.61E-01	9.50E-12	1.63E-11	NA
H-3	1.23E+01	2.30E+01	3.94E+01	NA
Hf-181	1.16E-01	3.70E-37	6.34E-37	NA

Table 3. (continued).

	Half-Life in Years	Activity (Ci) from EDF-ER-264[a]	Maximum Concentration (pCi/g) Calculated from EDF-ER-264	Concentration (pCi/L) Summed Over 15-Year Operational Period from EDF-ER-274[b]
Ho-166m	1.20E+03	1.30E-06	2.23E-06	NA
I-129	1.57E+07	6.10E-01	1.04E+00	1.26E+05
In-114	2.28E-06	8.90E-55	1.52E-54	NA
In-114m	1.36E-01	9.40E-55	1.61E-54	NA
In-115	4.60E+15	2.70E-12	4.62E-12	NA
K-40	1.28E+09	9.10E-01	1.56E+00	NA
Kr-81	2.10E+05	2.50E-09	4.28E-09	NA
Kr-85	1.07E+01	5.50E+02	9.42E+02	NA
La-140	4.59E-03	1.30E-105	2.23E-105	NA
Mn-54	8.56E-01	9.10E-09	1.56E-08	NA
Nb-92	3.60E+07	3.00E-19	5.14E-19	NA
Nb-93m	1.46E+01	6.40E-03	1.10E-02	NA
Nb-94	2.03E+04	4.20E-06	7.19E-06	NA
Nb-95	9.60E-02	2.30E-33	3.94E-33	NA
Nb-95m	9.88E-03	8.70E-36	1.49E-35	NA
Nd-144	5.00E+15	1.50E-10	2.57E-10	NA
Np-235	1.08E+00	3.20E-11	5.48E-11	NA
Np-236	1.15E+05	3.30E-08	5.65E-08	NA
Np-237	2.14E+06	3.00E-01	5.14E-01	NA
Np-238	5.80E-03	1.00E-07	1.71E-07	NA
Np-239	6.45E-03	1.60E-04	2.74E-04	NA
Np-240	1.24E-04	1.30E-14	2.23E-14	NA
Np-240m	1.41E-05	1.20E-11	2.05E-11	NA
Pa-231	3.73E+04	3.30E-05	5.65E-05	NA
Pa-233	7.39E-02	2.10E-02	3.60E-02	NA
Pa-234	7.64E-04	1.30E-06	2.23E-06	NA
Pa-234m	2.22E-06	8.10E-04	1.39E-03	NA
Pb-209	3.71E-04	2.30E-08	3.94E-08	NA
Pb-210	2.23E+01	5.20E-07	8.90E-07	NA
Pb-211	6.86E-05	8.70E-06	1.49E-05	NA

Table 3. (continued).

	Half-Life in Years	Activity (Ci) from EDF-ER-264[a]	Maximum Concentration (pCi/g) Calculated from EDF-ER-264	Concentration (pCi/L) Summed Over 15-Year Operational Period from EDF-ER-274[b]
Pb-212	1.21E-03	2.60E-04	4.45E-04	NA
Pb-214	5.10E-05	2.70E-06	4.62E-06	NA
Pd-107	6.50E+06	2.90E-03	4.97E-03	NA
Pm-146	5.53E+00	2.80E-03	4.79E-03	NA
Pm-147	2.62E+00	1.80E+02	3.08E+02	NA
Pm-148	1.47E-02	1.90E-59	3.25E-59	NA
Pm-148m	1.13E-01	3.90E-58	6.68E-58	NA
Po-210	3.79E-01	4.80E-07	8.22E-07	NA
Po-211	1.64E-08	3.20E-10	5.48E-10	NA
Po-212	9.44E-15	1.60E-04	2.74E-04	NA
Po-213	1.33E-13	2.10E-08	3.60E-08	NA
Po-214	5.20E-12	2.70E-06	4.62E-06	NA
Po-215	6.34E-11	8.70E-06	1.49E-05	NA
Po-216	4.63E-09	2.60E-04	4.45E-04	NA
Po-218	5.80E-06	2.70E-06	4.62E-06	NA
Pr-144	3.29E-05	8.40E-04	1.44E-03	NA
Pr-144m	1.37E-05	1.20E-05	2.05E-05	NA
Pu-236	2.85E+00	2.60E-06	4.45E-06	NA
Pu-237	1.24E-01	5.70E-59	9.76E-59	NA
Pu-238	8.78E+01	1.10E+02	1.88E+02	NA
Pu-239	2.41E+04	3.20E+00	5.48E+00	NA
Pu-240	6.57E+03	7.10E-01	1.22E+00	NA
Pu-241	1.44E+01	3.00E+01	5.14E+01	NA
Pu-242	3.76E+05	1.10E-04	1.88E-04	NA
Pu-243	5.65E-04	3.00E-16	5.14E-16	NA
Pu-244	8.26E+07	1.20E-11	2.05E-11	NA
Pu-246	2.97E-02	6.50E-26	1.11E-25	NA
Ra-222	1.20E-06	5.50E-117	9.42E-117	NA
Ra-223	3.13E-02	9.60E-06	1.64E-05	NA
Ra-224	9.91E-03	2.60E-04	4.45E-04	NA

Table 3. (continued).

	Half-Life in Years	Activity (Ci) from EDF-ER-264[a]	Maximum Concentration (pCi/g) Calculated from EDF-ER-264	Concentration (pCi/L) Summed Over 15-Year Operational Period from EDF-ER-274[b]
Ra-225	4.05E-02	2.40E-08	4.11E-08	NA
Ra-226	1.60E+03	2.20E-01	3.77E-01	NA
Ra-228	5.75E+00	7.20E-11	1.23E-10	NA
Rb-87	4.73E+10	5.30E-06	9.08E-06	NA
Rh-102	2.90E+00	1.40E-05	2.40E-05	NA
Rh-103m	1.07E-04	1.30E-58	2.23E-58	NA
Rh-106	9.51E-07	5.40E-03	9.25E-03	NA
Rn-218	1.11E-09	6.00E-117	1.03E-116	NA
Rn-219	1.25E-07	9.60E-06	1.64E-05	NA
Rn-220	1.76E-06	2.60E-04	4.45E-04	NA
Rn-222	1.05E-02	2.90E-06	4.97E-06	NA
Ru-103	1.08E-01	9.50E-30	1.63E-29	NA
Ru-106	1.01E+00	5.80E-03	9.93E-03	NA
Sb-124	1.65E-01	9.80E-41	1.68E-40	NA
Sb-125	2.77E+00	4.40E+00	7.53E+00	NA
Sb-126	1.24E+01	9.80E-03	1.68E-02	NA
Sb-126m	3.61E-05	7.00E-02	1.20E-01	NA
Sc-46	2.30E-01	1.30E-20	2.23E-20	NA
Se-79	6.50E+04	7.90E-02	1.35E-01	NA
Sm-146	7.00E+07	2.00E-10	3.42E-10	NA
Sm-147	1.06E+11	1.90E-06	3.25E-06	NA
Sm-148	1.20E+13	4.80E-13	8.22E-13	NA
Sm-149	4.00E+14	2.40E-12	4.11E-12	NA
Sm-151	9.00E+01	1.60E+02	2.74E+02	NA
Sn-119m	8.02E-01	7.00E-08	1.20E-07	NA
Sn-121m	7.60E+01	1.30E-02	2.23E-02	NA
Sn-123	3.54E-01	4.00E-17	6.85E-17	NA
Sn-126	1.00E+05	7.00E-02	1.20E-01	NA
Sr-89	1.38E-01	2.80E-44	4.79E-44	NA
Sr-90	2.86E+01	1.10E+04	1.88E+04	NA

Table 3. (continued).

	Half-Life in Years	Activity (Ci) from EDF-ER-264[a]	Maximum Concentration (pCi/g) Calculated from EDF-ER-264	Concentration (pCi/L) Summed Over 15-Year Operational Period from EDF-ER-274[b]
Tb-160	1.98E-01	1.50E-34	2.57E-34	NA
Tc-98	4.20E+06	8.40E-08	1.44E-07	NA
Tc-99	2.13E+05	2.70E+00	4.62E+00	2.50E+05
Te-123	1.00E+13	2.10E-15	3.60E-15	NA
Te-123m	3.28E-01	1.40E-23	2.40E-23	NA
Te-125m	1.59E-01	1.10E+00	1.88E+00	NA
Te-127	1.07E-03	4.40E-20	7.53E-20	NA
Te-127m	2.98E-01	4.50E-20	7.71E-20	NA
Te-129	1.32E-04	3.20E-71	5.48E-71	NA
Te-129m	9.20E-02	5.10E-71	8.73E-71	NA
Th-226	5.87E-05	1.00E-117	1.71E-117	NA
Th-227	5.13E-02	8.60E-06	1.47E-05	NA
Th-228	1.91E+00	1.60E-02	2.74E-02	NA
Th-229	7.34E+03	2.40E-08	4.11E-08	NA
Th-230	7.70E+04	8.20E-02	1.40E-01	NA
Th-231	2.91E-03	7.60E-02	1.30E-01	NA
Th-232	1.40E+10	7.40E-02	1.27E-01	NA
Th-234	6.60E-02	8.10E-04	1.39E-03	NA
Tl-207	9.07E-06	8.70E-06	1.49E-05	NA
Tl-208	5.80E-06	9.40E-05	1.61E-04	NA
Tl-209	4.18E-06	5.00E-10	8.56E-10	NA
Tm-170	3.52E-01	3.00E-26	5.14E-26	NA
Tm-171	1.92E+00	7.60E-13	1.30E-12	NA
U-232	7.20E+01	2.50E-04	4.28E-04	NA
U-233	1.59E+05	1.20E-05	2.05E-05	NA
U-234	2.44E+05	2.90E+00	4.97E+00	NA
U-235	7.04E+08	5.20E-02	8.90E-02	NA
U-236	2.34E+07	9.60E-02	1.64E-01	NA
U-238	4.47E+09	9.20E-01	1.58E+00	3.20E+02
U-240	1.61E-03	1.20E-11	2.05E-11	NA

Table 3. (continued).

	Half-Life in Years	Activity (Ci) from EDF-ER-264[a]	Maximum Concentration (pCi/g) Calculated from EDF-ER-264	Concentration (pCi/L) Summed Over 15-Year Operational Period from EDF-ER-274[b]
Xe-127	9.97E-02	7.50E-73	1.28E-72	NA
Xe-131m	3.24E-02	1.30E-112	2.23E-112	NA
Y-90	7.31E-03	1.10E+04	1.88E+04	NA
Y-91	1.60E-01	2.00E-37	3.42E-37	NA
Zn-65	6.69E-01	1.30E-09	2.23E-09	NA
Zr-93	1.53E+06	4.10E-01	7.02E-01	NA
Zr-95	1.75E-01	1.40E-25	2.40E-25	NA

a. Curie totals for radionuclides in EDF-ER-264 represent activity as of 1/1/2002.

b. mg/L totals for radionuclides in EDF-ER-274 were converted to pCi/L using published half-lives and atomic weights.

c. NA indicates a leachate concentration was not calculated for this radiological COPC.

Values for radiological contaminants were calculated using the following equation:

((activity of the contaminant (pCi)) / (density (1500 kg/m^3))*(soil volume (389,000 m^3))*1000 g/kg = concentration (pCi/g).

Values for inorganic and organic contaminants were calculated using the following equation:

(contaminant mass (mg)) / (density (1500 kg/m^3))*(soil volume (389,000 m^3)) = concentration (mg/kg).

The IDCF Design Inventory (EDF-ER-264) was also the basis for the development of the concentrations of selected design inventory constituents in the ICDF landfill leachate water simulated over the 15-year operations period and documented in the EDF titled "Leachate/Contaminant Reduction Time Study (Title I)" (EDF-ER-274). The leachate/contaminant reduction time study was used to conservatively model the change in leachate concentration over time, as it is directed toward the evaporation pond. The results indicate less than 10% of the inventory masses of the most mobile constituents (iodine and technetium) are expected to be removed from the landfill during the operation period. The leachate concentrations from this study were summed over the 15-year period for those contaminants of concern and are presented in Tables 2 and 3. As stated, no organics were identified as concerns for the leachate in EDF-ER-274. These contaminants were evaluated using the approach for aquatic receptors as discussed below.

1.1.2 Ecosystem Characterization

The INEEL is located in a cool desert ecosystem characterized by shrub-steppe vegetative communities typical of the northern Great Basin and Columbia Plateau region. The surface of the INEEL is relatively flat with several prominent volcanic buttes and numerous basalt flows that provide important habitat for small and large mammals, reptiles, and some raptors. The shrub-steppe communities are dominated by sagebrush (*Artemisia* spp.) and provide habitat for sagebrush community species such as sage grouse (*Centrocercus urophasianus*), pronghorn antelope (*Antilocapra americana*), and sage sparrows *(Amphispiza belli).* Other communities include rabbitbrush *(Chrysothamnus* spp.), grasses and forbs, salt desert shrubs *(Atriplex* spp.), and exotic or weed species. Juniper woodlands are located near the buttes and in the northwest portion of INEEL. The juniper woodlands provide important habitat for raptors and large mammals. Limited riparian communities exist on the INEEL along intermittently flowing waters of the Big Lost River and Birch Creek drainages. Stream flow that reaches the INEEL flows to the Big Lost River playa or the Birch Creek playa, in which the flow is lost to evaporation and infiltration.

1.1.2.1 Abiotic Components. The INTEC facility is located on the alluvial plain of the Big Lost River. The main channel of the Big Lost River passes within 100 m of the northwest corner of INTEC facility fences along its route to the Sinks (approximately 18 km [11 mi] to the north).

The topography surrounding the INTEC is relatively flat. The soils surrounding the facilities are comprised primarily of Typic-Camborthids-Typic Calciorthids (TCC), Typic Torrifluvents (TTF) and Malm-Bondfarm-Matheson complex (432) soils.

Both TCC and TTF soils are alluvium, which are deposited by the Big Lost River. TTF soils are somewhat newer than TCC soils and are found in closer proximity to the river. The TCC soils are loams or silty loams over gravelly or sandy loams, and the surface is frequently hardened due to alkaline conditions. The TTF soils are also loams or sandy loams over gravelly subsoils. However, the gravels associated with TTF soils are finer and more frequently found on the surface than those of TCC soils. Both soil types are often dry and generally alkaline and saline, impermeable, erodible and have little organic accumulation in the upper layer (Olson, Jeppsen, and Lee 1995). Spring thaws and intense rainstorms may lead to significant soil erosion in these soil types.

1.1.2.2 Biotic Components. Sagebrush-steppe habitat on the INEEL supports a number of species including sage grouse, pronghorn, elk (*Cervus elaphus*), and waterfowl (all these are important game species). Grasslands provide habitat for species such as the western meadowlark (*Sturnella neglecta*) and mule deer (also a game species). Rock outcroppings support species such as bats, woodrats (*Neotoma cinerea*), and sensitive species such as the pygmy rabbit (*Brachylagus idahoensis*). The INTEC site is comprised of about 85 percent bare ground and about 13 percent facilities. However, buildings, lawns and ornamental vegetation, and wastewater treatment ponds at INTEC are utilized by a number of species such as waterfowl, raptors, rabbits, and bats. No areas of critical habitat (having significant value for supporting sensitive and/or unique plant and wildlife species and communities on site) are known to exist within the assessment area.

The flora and fauna existing in the assessment area are representative of those found across the INEEL and are described in the following subsections. Flora was determined using a vegetation map constructed for the INEEL using Landsat imagery and field measurements from vegetation plots (EG&G Idaho 1993). Fauna was characterized using a 1986 vertebrate survey performed on the INEEL (Reynolds et al. 1986) and data collected subsequent to that survey. The flora and fauna present in the assessment area have not been verified with a comprehensive field survey. However, information presented here is supported by previous field surveys and observations described in the WAG 3 Ecological Risk Assessment conducted as part of the OU 3-13 Comprehensive RI/FS (DOE-ID 1997).

1.1.2.3 Flora. The 15 INEEL vegetation cover classes defined using Landsat imagery data (Kramber et al. 1992) have been combined into eight cover classes applied for INEEL ERAs (VanHorn, Hampton, and Morris 1995). Six of the eight vegetation cover classes are represented in or near the assessment area: sagebrush-steppe on lava, sagebrush/rabbitbrush, grassland, salt desert shrub, playa-bare ground/disturbed, and juniper. The species composition for each of these classes is summarized in Table 4. Sagebrush-steppe on lava and sagebrush/rabbitbrush are the two predominant vegetation types found in the assessment area. The dominant vegetation species within these two communities is Wyoming big sagebrush (*Artemisia tridentata* spp. *wyomingensis*). Grasslands present in the area are comprised primarily of wheat grasses (*Agropyron* spp., *Elymus* spp).

Table 4. Species composition near the ICDF assessment area and vegetation classes.

Vegetation Cover Class	INEEL Vegetation Cover Class	Dominant Species
Grasslands	Steppe Basin wildrye Grassland	*Leymus cinereus* *Descurainia sophia* *Sisymbrium altissimum* *Elymus lanceolatus* *Artemisia tridentata* ssp. *wyomingensis* *Elymus elymoides* *Chrysothamnus viscidiflorus*
Sagebrush/rabbitbrush	Sagebrush-steppe off lava Sagebrush-winterfat Sagebrush-rabbitbrush	*Artemisia tridentata* ssp. *wyomingensis* *Chrysothamnus viscidiflorus* *Bromus tectorum* *Sisymbrium altissimum* *Achnatherum hymenoides*
Salt desert shrubs	Salt desert shrub	*Atriplex nuttallii* *Atriplex canescens* *Atriplex confertifolia* *Krascheninnikovia lanata*
Sagebrush-steppe on lava	Sagebrush-steppe on lava	*Artemisia tridentata* ssp. *wyomingensis* *Achnatherum hymenoides* *Chrysothamnus viscidiflorus*
Playa-bare ground/disturbed areas	Playa-bare ground/gravel borrow pits, old fields, disturbed areas, seedings	*Kochia scoparia* *Salsola kali* *Artemisia tridentata* ssp. *wyomingensis* *Chrysothamnus viscidiflorus*

1.1.2.4 Fauna. For initial assessment, species were grouped using a functional grouping approach as discussed in detail in VanHorn, Hampton, and Morris (1995). The list (Table 5) incorporates functional grouping as described in the Guidance Manual (VanHorn, Hampton, and Morris 1995). The functional grouping approach is designed to group similar species to aid in analyzing the effects of stressors on INEEL ecosystem components. The primary purpose of functional grouping is to apply existing data from one or more species within the group to assess the risk to the group as a whole. Functional groups are used to perform a limited evaluation of exposures for all potential receptors and provide a mechanism for focusing subsequent analyses on receptors that best characterize potential contaminant effects. Species characteristics including trophic level, breeding, and feeding locations were used to construct functional groups for INEEL species. Individual groups were assigned a unique identifier consisting of a one- or two-letter code to indicate taxon (A = amphibians, AV = birds, M = mammals, R = reptiles, I = insects), and a three-digit code derived from the combination of trophic category and feeding habitats. For example, AV122 represents the group of seed-eating (herbivorous) bird species whose feeding habitat is the terrestrial surface and/or understory. The trophic categories (first digit in three-digit code) are 1= herbivore, 2= insectivore, 3= carnivore, 4= omnivore, and 5= detrivore. The feeding habitat codes (second and third digits in three-digit code) are derived from the following:

Table 5. Threatened or endangered species, sensitive species, and species of concern that may be found on the INEEL.[a]

Common Name	Scientific Name	Federal Status[b,c]	State Status[c]	BLM Status[c]	USFS[f] Status[c]
Plants					
Lemhi milkvetch	*Astragalus aquilonius*	—	S	S	S
Painted milkvetch[e]	*Astragalus ceramicus var. apus*	3c	R	—	—
Plains milkvetch	*Astragalus gilviflorus*	NL	1	S	S
Winged-seed evening primrose	*Camissonia pterosperma*	NL	S	S	—
Nipple cactus[e]	*Coryphantha missouriensis*	NL	R	—	—
Spreading gilia	*Ipomopsis (=Gilia) polycladon*	NL	2	S	—
King's bladderpod	*Lesquerella kingii var. cobrensis*	—	M	—	—
Tree-like oxytheca[e]	*Oxytheca dendroidea*	NL	R	R	—
Inconspicuous phacelia[d]	*Phacelia inconspicua*	C2	SSC	S	S
Ute ladies' tresses[d]	*Spiranthes diluvialis*	LT	—	—	—
Puzzling halimolobos	*Halimolobos perplexa var. perplexa*	—	M	—	S
Birds					
Peregrine falcon	*Falco peregrinus*	3c	E	—	—
Merlin	*Falco columbarius*	NL	—	S	—
Gyrfalcon	*Falco rusticolus*	NL	SSC	S	—
Bald eagle	*Haliaeetus leucocephalus*	LT	T	—	—
Ferruginous hawk	*Buteo regalis*	C2	SSC	S	—
Black tern	*Chlidonias niger*	C2	—	—	—
Northern pygmy owl[d]	*Glaucidium gnoma*	—	SSC	—	—
Burrowing owl	*Athene cunicularia*	C2	—	S	—
Common loon	*Gavia immer*	—	SSC	—	—
American white pelican	*Pelicanus erythrorhynchos*	—	SSC	—	—
Great egret	*Casmerodius albus*	—	SSC	—	—
White-faced ibis	*Plegadis chihi*	C2	—	—	—
Long-billed curlew	*Numenius americanus*	3c	—	S	—
Loggerhead shrike	*Lanius ludovicianus*	C2	NL	S	—
Northern goshawk	*Accipiter gentilis*	C2	S	—	S
Swainson's hawk	*Buteo swainsoni*	—	—	S	—
Trumpeter swan	*Cygnus buccinator*	C2	SSC	S	S
Sharptailed grouse	*Tympanuchus phasianellus*	C2	—	S	S
Boreal owl	*Aegolius funereus*	—	SSC	S	S
Flammulated owl	*Otus flammeolus*	—	SSC	—	S

Table 5. (continued).

Common Name	Scientific Name	Federal Status[b,c]	State Status[c]	BLM Status[c]	USFS[f] Status[c]
Mammals					
Gray wolf[g]	*Canis lupus*	LE/XN	E	—	—
Pygmy rabbit	*Brachylagus (=Sylvilagus) idahoensis*	C2	SSC	S	—
Townsend's Western big-eared bat	*Corynorhinus (=Plecotus) townsendii*	C2	SSC	S	S
Merriam's shrew	*Sorex merriami*	—	S	—	—
Long-eared myotis	*Myotis evotis*	C2	—	—	—
Small-footed myotis	*Myotis ciliolabrum (=subulatus)*	C2	—	—	—
Western pipistrelle[d]	*Pipistrellus hesperus*	NL	SSC	—	—
Fringed myotis[d]	*Myotis thysanodes*	—	SSC	—	—
California myotis[d]	*Myotis californicus*	—	SSC	—	—
Reptiles and amphibians					
Northern sagebrush lizard	*Sceloporus graciosus*	C2	—	—	—
Ringneck snake[d]	*Diadophis punctatus*	C2	SSC	S	—
Night snake[e]	*Hypsiglena torquata*	—	—	R	—
Insects					
Idaho pointheaded grasshopper[d]	*Acrolophitus punchellus*	C2	SSC	—	—
Fish					
Shorthead sculpin[d]	*Cottus confusus*	—	SSC	—	—

a. This list was compiled from a letter from the U.S. Fish and Wildlife Service (USFWS) (1997) for threatened or endangered, and sensitive species listed by the Idaho Department of Fish and Game (IDFG) Conservation Data Center (CDC 1994 and IDFG web site 1997) and Radiological Environmental Sciences Laboratory documentation for the INEEL (Reynolds et al. 1986).

b. The USFWS no longer maintains a candidate (C2) species listing but addresses former listed species as "species of concern" (USFWS 1996). The C2 designation is retained here to maintain consistency between completed and ongoing INEEL ERA assessments.

c. Status codes: INPS = Idaho Native Plant Society; S = sensitive; 2 = State Priority 2 (INPS); 3c = no longer considered for listing; M = State of Idaho monitor species (INPS); NL = not listed; 1 = State Priority 1 (INPS); LE = listed endangered; E = endangered; LT = listed threatened; T = threatened; XN = experimental population, nonessential; SSC = species of special concern; and C2 = see item b, formerly Category 2 (defined in CDC 1994). BLM = Bureau of Land Management; R = removed from sensitive list (nonagency code added here for clarification).

d. No documented sightings at the INEEL; however, the ranges of these species overlap the INEEL and are included as possibilities to be considered for field surveys.

e. Recent updates that resulted from Idaho State Sensitive Species meetings (BLM, USFWS, INPS, and U.S. Forest Service [USFS]) - (INPS 1995, 1996, and 1997).

f. U.S. Forest Service (USFS) Region 4.

g. Anecdotal evidence indicates that isolated wolves may occur on the INEEL. However, no information exists to substantiate hunting or breeding on site (Morris 1998). Currently under consideration for de-listing.

1.0 Air

2.0 Terrestrial

- 2.1 Vegetation canopy
- 2.2 Surface/understory
- 2.3 Subsurface
- 2.4 Vertical habitat (man-made structures, cliffs, etc.)

3.0 Terrestrial/Aquatic Interface

- 3.1 Vegetation canopy
- 3.2 Surface/understory
- 3.3 Subsurface
- 3.4 Vertical habitat

4.0 Aquatic

- 4.1 Surface water
- 4.2 Water column
- 4.3 Bottom

The list of species potentially present in the assessment area was developed by updating 1986 data on the relative abundance, habitat use, and seasonal presence of fish, amphibians, reptiles, birds, and mammals recorded on the INEEL (Reynolds et al. 1986), and communicating with INEEL researchers and personnel conducting ecological studies since 1986. Fauna that are not supported by the existing habitat or that are rare or uncommon or otherwise unlikely to be found in the assessment area were not included in the literature search for species-specific exposure data and toxicity data. Those species are represented by the functional group with which they are associated. A complete list of species within individual functional groups, as well as those not included in the literature search can be found in VanHorn, Hampton, and Morris (1995). No surface hydrology exists to support fish, and they are therefore not evaluated.

Although some population studies have been conducted for cyclic rabbit and rodent populations, several game species (e.g., pronghorn, sage grouse), and raptors, no recent comprehensive studies have been conducted to assess either WAG-specific or INEEL-wide wildlife population status and/or trends with respect to contaminant effects.

Wildlife species present near or within the assessment area include birds, mammals, and reptiles that are associated with facilities, sagebrush-steppe, rock outcroppings, shrubs, and grasslands. The varying behaviors of these species include but are not limited to grazing and browsing on vegetation, burrowing and flying, and preying on insects and small mammals. If prey, such as a small mammal, becomes contaminated by ingesting contaminated soil or vegetation, and is then consumed by a predator, such as a ferruginous hawk, the contamination can be taken offsite when the hawk returns to its nest to feed nestlings.

The flora and fauna potentially present within the assessment area are combined into a simplified food web model. Variability in environmental conditions, such as population sizes or seasons, is not considered in this model, and a constant environment is assumed. Present near or at the site are decomposers, producers (vegetation), primary consumers or herbivores (e.g., rodents), secondary consumers or carnivores (e.g., snakes), and tertiary or top carnivores (e.g., raptors). These relationships were incorporated to identify direct and indirect exposure to contaminants for the CSM. This model depicts the possible transport of ICDF contaminants through the food web (Figure 3).

1.1.2.5 Threatened, Endangered and Sensitive Species. A list of threatened and endangered (T/E) and sensitive species was compiled from the U.S. Fish and Wildlife Service (Martin 1996), the Idaho Department of Fish and Game Conservation Data Center threatened, endangered, and sensitive species for the State of Idaho (CDC 1994); and Radiological and Environmental Sciences Laboratory (RESL) documentation for the INEEL (Reynolds et al. 1986). T/E and sensitive species, or species of concern, that could exist in the ICDF Complex assessment area are listed in Table 5.

Avian species include these six terrestrial species: the ferruginous hawk (*Buteo regalis*), the peregrine falcon (*Falco peregrinus*), the northern goshawk (*Accipiter gentilis*), the loggerhead shrike (*Lanius ludovicianus*), the burrowing owl (*Athene cunicularia*), and the bald eagle (*Haliaeetus leucocephalus*). Three avian aquatic species, the white-faced ibis (*Plegadis chihi*), the black tern (*Childonias niger*), and the trumpeter swan (*Cygnus buccinator*) are listed. However, these species are listed as either rare or vagrant/accidental species and are not expected to use the ponds in this area (VanHorn, Hampton, and Morris 1995).

Five mammalian species of concern potentially occur near the assessment: the pygmy rabbit (*Brachylagus idahoensis*), Townsend's western big-eared bat (*Plecotus townsendii*), long-eared myotis (*Myotis evotis*), small-footed myotis (*Myotis subulatus*) and gray wolf (*Canis lupus*). The occurrence of the gray wolf on the INEEL is unverified. It is listed because of anecdotal evidence (DOE-ID 1999) and the fact that the wolf is federally listed.

The sagebrush lizard (*Sceloporous graciosus*) is the only reptile species of concern with a potential presence in the assessment area. No critical habitat, as defined in 40 CFR 300, is known to exist in the assessment area.

A survey to evaluate suitable habitat for T/E and species of concern in areas immediately surrounding INTEC was conducted in 1996 (DOE-ID 1999).

In 1996, field surveys were conducted in the areas surrounding WAG 3 facilities to assess the presence and use of those areas by T/E species or other species of special concern (i.e., species formerly designated as C2). The survey findings have been documented in reports that include survey protocols and results for WAG 3 (DOE-ID 1999). Specific information collected and reported for each T/E or species of special concern includes:

- Date and conditions under which the surveys were conducted
- Area encompassed by the surveys (global positioning system [GPS] mapping where practical)
- GPS locations for observed habitat, sign, and species sighted (where practicable)

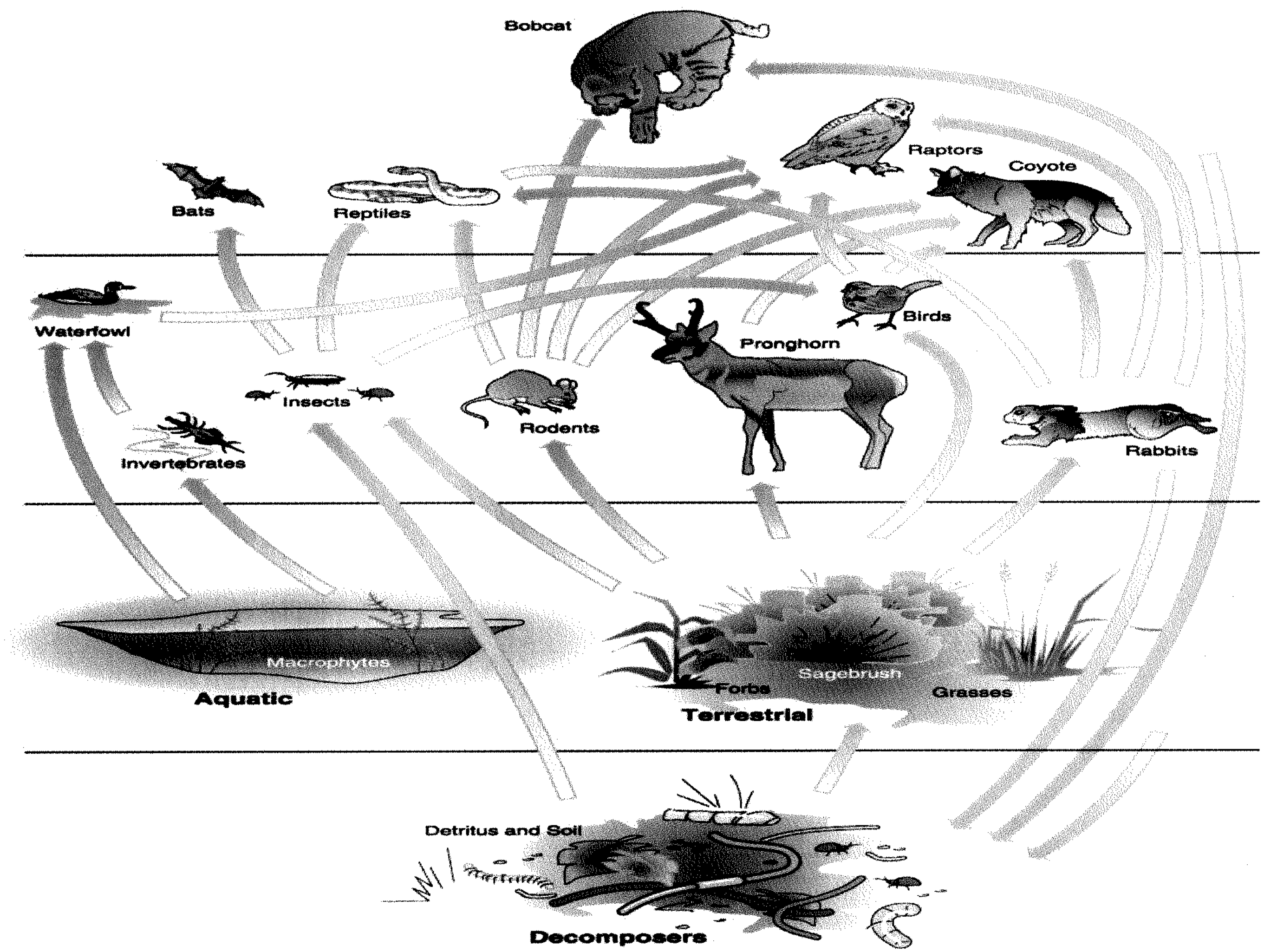

Figure 3. Simplified food web model from the INEEL.

- Habitat description, the proximity to WAG or site, and an estimate of whether contaminated sites or areas are within the home range of members of the species in question

- Species presence, abundance, current site use, past site use (historical sightings or surveys), and anticipated site use (professional judgment)

- An estimated site or area population (where possible).

1.1.3 Pathways of Contaminant Migration and Exposure

Contaminated subsurface soil represents the major source of possible contaminant exposure for ecological components within the ICDF assessment area. Surface soil and surface water pathways were not analyzed as part of this assessment due to the nature of the planned ICDF landfill process of burying the contaminated soil beneath two feet of gravel. Table 6 summarizes the exposure media for INEEL functional groups.

1.1.4 Assessment Endpoints

Assessment endpoints are "formal expressions of the actual environmental values that are to be protected" (Suter 1989). Assessment endpoints developed for this SLERA are presented on Table 7. The endpoints were developed around the protection of INEEL biota represented by functional groups and individual T/E and sensitive species known to exist at WAG 3 and identified as having potential for exposure to COPCs. Each T/E and sensitive species with the potential for exposure is addressed individually in the risk analysis, whereas potential effects to other receptors of concern are dealt with at the functional group level. Assessment endpoints defined for the SLERA reflect INEEL-wide hazard/policy goals discussed in the Guidance Manual (VanHorn, Hampton, and Morris 1995) and incorporate the suggested criteria for developing assessment endpoints, including ecological relevance and policy goals (EPA 1992, Suter 1993).

These assessment endpoints are the focus for SLERA risk characterization, and they link the measurement endpoints to the SLERA goals. The primary objective of this SLERA is to identify COPCs and levels of those contaminants that represent potential risk to ecological components in the assessment area. Consequently, toxic effects to ecological components as a result of exposure to COPCs were considered a primary concern for biota. Although adverse effects due to physical stressors are also of concern in evaluating potential risks to INEEL ecological components, these effects are not addressed by this SLERA.

1.1.5 Measurement Endpoint Selection

This section describes the selection of measurement endpoints for the ICDF SLERA. Measurement endpoints are measurable responses of ecological receptors to contaminants that can be related to SLERA assessment endpoints. For this SLERA, ecological components (flora and fauna) inside the assessment area were not measured or surveyed directly. Rather, published references were used as the primary sources of ecological and toxicological data from which measurement endpoints were derived. Values extracted from these references were used to calculate doses for all ecological receptors and to develop TRVs for contaminants.

Table 6. Summary of ICDF exposure media and ingestion routes for INEEL functional groups (ingestion of surface water from the evaporation pond is modeled for all groups).

Receptor	Subsurface Soils	Vegetation	Prey Consumption		
			Invertebrates	Mammals	Birds
Avian herbivores (AV122)	—	X	—	—	—
Avian insectivores (AV210A)	—	—	X	—	—
Avian insectivores (AV222)	—	—	X	—	—
Avian insectivores (AV232)	—	—	X	—	—
Avian carnivores (AV310)	—	—	—	X	X
Northern goshawk	—	—	—	X	X
Peregrine falcon	—	—	—	X	—
Avian carnivores (AV322)	—	—	—	X	—
Bald eagle	—	—	—	X	—
Ferruginous hawk	—	—	—	X	—
Loggerhead shrike	—	—	—	X	X
Avian carnivores (AV322A) Burrowing owl	X	—	X	X	—
Avian omnivores (AV422)	—	X	X	X	X
Mammalian herbivores (M122)	—	X	—	—	—
Mammalian herbivores (M122A)	X	X	—	—	—
Pygmy rabbit	X	X	—	—	—
Mammalian insectivores (M210A)	—	—	X	—	—
Townsend's western big-eared bat	—	—	X	—	—
Small-footed myotis	—	—	X	—	—
Long-eared myotis	—	—	X	—	—
Mammalian insectivores (M222) Merriam's shrew	X	—	X	—	—
Mammalian carnivore (M322)	X	—	—	X	—
Mammalian omnivores (M422)	X	X	X	—	—
Reptilian carnivores (R322)	X	—	—	X	—
Plants	X	—	—	—	—

Table 7. Summary of assessment endpoints for ICDF.[a]

Management Goal	ICDF SLERA Assessment Endpoint	Indicator of Risk
Maintain INEEL T/E individuals and populations by limiting exposure to organic, inorganic, and radionuclide contamination.	Survival of T/E individuals and reproductive success of T/E populations: northern goshawk, burrowing owl, ferruginous hawk, pygmy rabbit, Townsend's western big-eared bat, long-eared myotis, small-footed myotis, and sagebrush lizard	HI target exceeded
Maintain abundance and diversity of INEEL native biota by limiting exposure to organic, inorganic, and radionuclide contamination.	Survival and growth of native vegetation	Plant toxicity screening benchmark exceeded
	Survival and reproduction of wildlife populations (identified in the site conceptual model: waterfowl, small mammals, large mammals, song birds, raptors, top predators; represented by functional groups)	HI target exceeded

a. Suter (1993).

Table 8 summarizes the measurement endpoints developed to address ICDF Complex SLERA assessment endpoints. Quantified critical exposure levels (QCELs) and adjustment factors (AFs) were constructed from the literature to develop appropriate TRVs for receptors associated with ICDF contaminant pathways. Criteria for development of these TRVs are discussed in the Guidance Manual (VanHorn, Hampton, and Morris 1995). In general, the criteria incorporate the requirements for appropriate measurement endpoints, including relevance to an assessment endpoint, applicability to the route of exposure, use of existing data, and consideration of scale (VanHorn, Hampton, and Morris 1995).

Values for species dietary habits, home ranges, site use, exposure duration (ED), soil ingestion, food digestion, and body weights for the representative species are documented in Appendix D of the OU 10-04 Comprehensive RI/FS work plan (DOE-ID 1999) or as discussed in Section 4. The modeled concentrations of contaminants in each media were used to calculate dose for each affected receptor.

The measurement endpoints are the modeled dose as compared to the TRVs for each contaminant for each individual receptor. The modeled dose was divided by the TRV to produce hazard quotients (HQs) for each contaminant and receptor of concern. The HQs are then summed by receptor to determine a hazard index (HI). The HI is ultimately used to measure whether the assessment endpoints have been attained, that is, survival and reproductive success are ensured for the receptor groups being assessed (HIs are less than target value for all receptors for each contaminant).

Table 8. Summary of ICDF SLERA endpoints.

ICDF Assessment Endpoint	Ecological Component	Functional Group (Other Groups Represented)	Measurement Species (Toxicity Reference Value Test Species)
No indication of possible effects on T/E and C2 individuals and populations as a result of contaminant exposure	Pygmy rabbit	M122A (M123)	Rat, mouse/meadow vole (M122A), and deer mouse (M422)
	Gray wolf	M322	Dog, mouse (M422)
	Peregrine falcon, and northern goshawk	AV310	Chicken, goshawk, and American kestrel/red-tailed hawk (AV322)
	Ferruginous hawk, loggerhead shrike, bald eagle, and burrowing owl	AV322, AV322A	Chicken, goshawk, and American kestrel/red-tailed hawk (AV322)
	Sagebrush lizard	R222	None located
	Bats	M210, M210A	Rat, mouse/meadow vole (M122A), and deer mouse (M422)
No indication of possible effects on native vegetation communities as a result of contaminant exposure	Vegetation	Sagebrush and bunchgrass	Bush beans and crop plants
No indication of possible effects on wildlife populations as a result of contaminant exposure (represented by functional groups identified in the site conceptual model: small mammals, large mammals, song birds, raptors, and top predators, invertebrates)	Small mammals	M422, M122A (M222, M123)	Rat, mouse/meadow vole (M122A), and deer mouse (M422)
	Mammalian carnivores and omnivores	M422A, M322	Rat, mouse, dog, cat, and mink/fox
	Mammalian herbivores	M121, M122, M122A	Rat, mouse, and mule deer/pronghorn
	Avian carnivores	AV322, AV322A, M122A	Goshawk (AV310) and American kestrel/red-tailed hawk (AV322)
	Avian herbivores	AV121, AV122	Chicken, pheasant, quail, and passerines/sharp-tailed and ruffed grouse
	Avian insectivore	AV210, AV222 (AV210A, AV221, AV22A)	Chicken, pheasant, quail, passerines/American robin (AV222), and cliff swallow (AV210A)
	Avian omnivores	AV422	Chicken, pheasant, turkey, black, mallard
	Mammalian insectivore	M210A (M210)	Rat, mouse/meadow vole (M122A), and deer mouse (M422)
	Reptiles	R222, R322	Western racer (none located)
	Invertebrates	Phytophagous, saprophagous, and entomophagous	Unidentified

1.1.6 Conceptual Site Model

The pathways/exposure models for surface soil, subsurface soil, and surface water were integrated to produce a general sitewide conceptual model that is used to tentatively represent the ICDF Complex shown in Figure 4. This model reflects both direct (as discussed in previous sections) and indirect (i.e., predation) receptor exposure pathways for ICDF COPCs. The CSM is a general sitewide model and does not show an exact representation of the ICDF Complex. The INEEL CSM is shown only to depict possible pathways that may occur at the ICDF Complex.

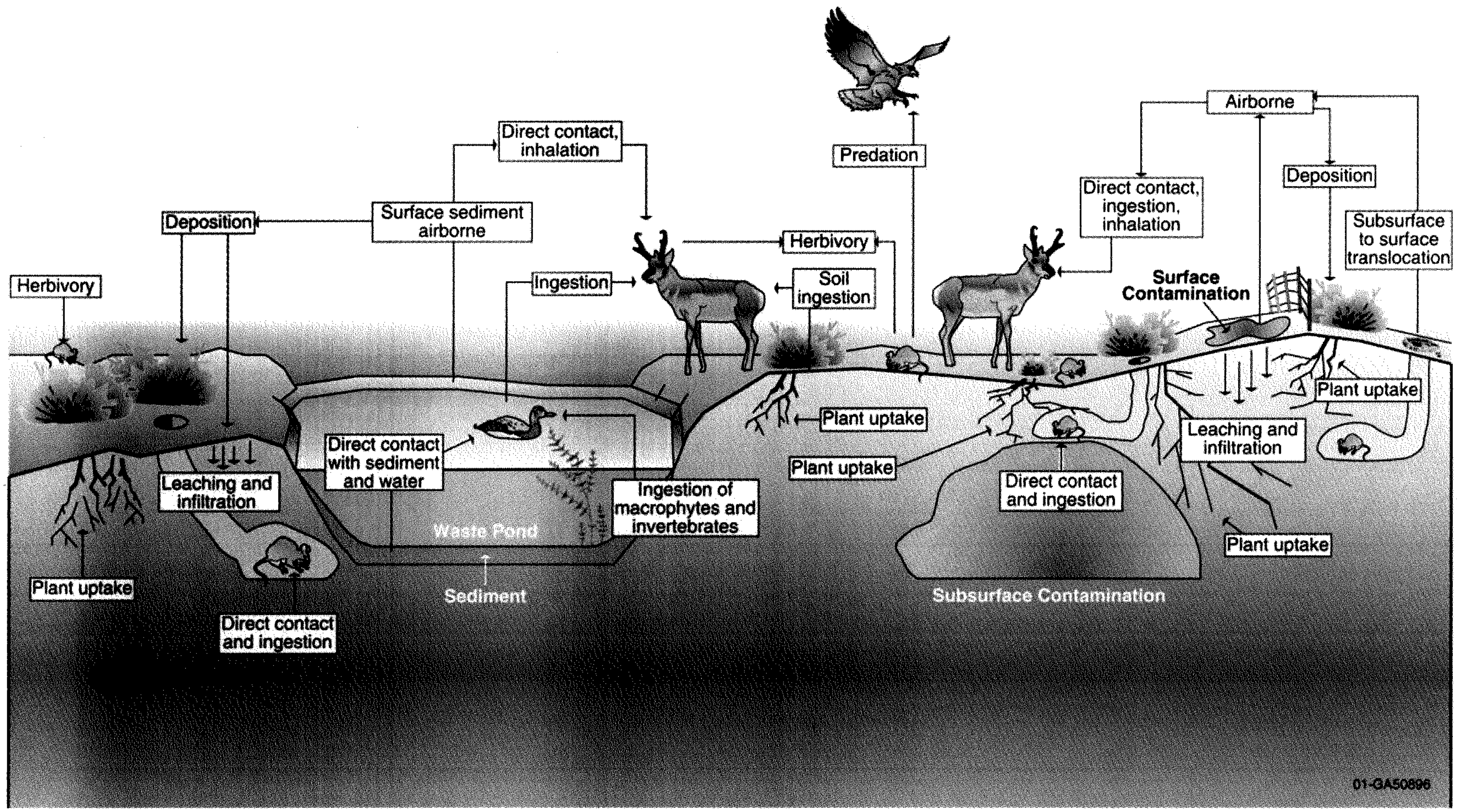

Figure 4. INEEL ecological conceptual site model showing pathways that may be present at the ICDF Complex.

2. DEVELOPMENT OF ECOLOGICALLY BASED SCREENING LEVELS

Ecological based screening levels (EBSL) for functional groups and selected individuals were developed by inverting exposure calculations. This process is presented in this section.

2.1 Exposure Calculations for Non-Radionuclides

Potential exposures for functional groups, including T/E and sensitive species were determined based on site-specific life history and feeding habits when possible. Quantification of group and individual exposures incorporated species-specific numerical exposure factors including body weight, ingestion rate (IR), and fraction of diet composed of vegetation or prey, and soil consumed from the affected area. Parameters used to model contaminant intakes by the functional groups and species (assessment endpoints) are presented in Table 9. These values were derived from a combination of parameters that produced the most conservative overall exposure for the group. The functional group parameters in Table 10 represent the most conservative combination of percent prey (PP), percent vegetation (PV), percent soil (PS), ED, IR, body weight, and home ranges from species within the functional group. The input parameters and exposure equations are documented in detail in the OU 10-04 RI/FS work plan (DOE-ID 1999).

2.1.1 Exposure Modeling

The exposure equation used to calculate average daily soil intake is used to calculate the dose to functional groups and T/E species. For example, dose (intake) in mg/kg body weight-day can be estimated using the following equation, as adapted from EPA's *Wildlife Exposure Factors Handbook* (EPA 1993):

$$EE_{total} = EE_{soil/food} + EE_{water} \tag{1}$$

where

EE_{total}	=	total estimated intake from ingestion of soil, food, and water (mg/kg bodyweight-day)
$EE_{soil/food}$	=	estimated intake from ingestion of food and soil (mg/kg bodyweight-day)
EE_{water}	=	estimated intake from ingestion of water (mg/kg bodyweight-day).

Table 9. Parameter input values for EBSL calculations.

Functional Groups	PP	PV	PS	SUF	ED	IR (kg/day)	WI (L/day)	BW (kg)	PS Model Species[a]
Amphibians (A232)	9.41E-01	0.00E+00	5.90E-02	1.00E-00	1.00E-00	6.49E-05	0.00E+00	8.00E-03	Eastern painted turtle
Avian herbivores (AV121)	0.00E+00	9.90E-01	1.00E-02	1.00E-00	1.00E-00	3.50E-03	3.20E-03	1.29E-02	Estimated
Avian herbivores (AV122)	0.00E+00	9.07E-01	9.30E-02	1.00E-00	1.00E-00	1.46E-03	1.33E-03	3.50E-03	Wild turkey
Avian herbivores (AV132)	0.00E+00	8.20E-01	1.80E-01	1.00E-00	1.00E-00	1.07E-02	1.04E-02	7.46E-02	Western sandpiper
Avian herbivores (AV142)	0.00E+00	9.18E-01	8.20E-02	1.00E-00	1.00E-00	2.75E-02	2.73E-02	3.16E-01	Canada goose
Trumpeter swan	0.00E+00	9.18E-01	8.20E-02	1.00E-00	1.00E-00	2.75E-01	2.90E-02	1.09E+01	Canada goose
Avian herbivores (AV143)	0.00E+00	9.18E-01	8.20E-02	1.00E-00	1.00E-00	2.92E-02	2.92E-01	3.47E-01	Canada goose
Avian insectivores (AV210)	9.80E-01	0.00E+00	2.00E-02	1.00E-00	1.00E-00	2.90E-03	2.70E-03	1.00E-02	Estimated
Black tern	9.80E-01	0.00E+00	2.00E-02	1.00E-00	1.00E-00	9.84E-03	9.48E-03	6.53E-02	Estimated
Avian insectivores (AV210A)	9.70E-01	0.00E+00	3.00E-02	1.00E-00	1.00E-00	3.89E-03	3.48E-03	1.46E-02	Burrowing owl
Avian insectivores (AV221)	9.70E-01	0.00E+00	3.00E-02	1.00E-00	1.00E-00	1.99E-03	2.05E-03	6.65E-03	Burrowing owl
Avian insectivores (AV222)	9.07E-01	0.00E+00	9.30E-02	1.00E-00	1.00E-00	3.07E-03	2.86E-03	1.09E-02	Wild turkey
Avian insectivores (AV222A)	9.07E-01	0.00E+00	9.30E-02	1.00E-00	1.00E-00	2.82E-03	2.70E-03	1.00E-02	Wild turkey
Avian insectivores (AV232)	8.20E-01	0.00E+00	1.80E-01	1.00E-00	1.00E-00	1.12E-03	1.01E-03	2.32E-02	Western sandpiper
Avian insectivores (AV233)	8.20E-01	0.00E+00	1.80E-01	1.00E-00	1.00E-00	4.78E-03	4.50E-03	2.15E-02	Western sandpiper

Table 9. (continued).

Functional Groups	PP	PV	PS	SUF	ED	IR (kg/day)	WI (L/day)	BW (kg)	PS Model Species[a]
White-faced ibis	8.90E-01	0.00E+00	1.10E-01	1.00E-00	1.00E-00	4.27E-02	4.29E-02	6.22E-01	Western sandpiper
Avian insectivores (AV241)	8.20E-01	0.00E+00	1.80E-01	1.00E-00	1.00E-00	6.41E-03	6.10E-03	3.38E-02	Western sandpiper
Avian insectivores (AV242)	8.20E-01	0.00E+00	1.80E-01	1.00E-00	1.00E-00	1.13E-02	1.10E-02	8.10E-02	Wood duck
Avian carnivores (AV310)	9.80E-01	0.00E+00	2.00E-02	1.00E-00	1.00E-00	1.61E-02	1.57E-02	1.39E-01	Wood duck
Northern goshawk	9.80E-01	0.00E+00	2.00E-02	1.00E-00	1.00E-00	6.00E-02	6.10E-02	1.05E-00	Estimated
Peregrine falcon	9.80E-01	0.00E+00	2.00E-02	1.00E-00	1.00E-00	4.96E-02	5.00E-02	7.82E-01	Estimated
Avian carnivores (AV322)	9.80E-01	0.00E+00	2.00E-02	1.00E-00	1.00E-00	7.44E-03	7.11E-03	4.25E-02	Estimated
Bald eagle	9.80E-01	0.00E+00	2.00E-02	1.00E-00	1.00E-00	1.60E-01	1.67E-01	4.74E-00	Estimated
Ferruginous hawk	9.80E-01	0.00E+00	2.00E-02	1.00E-00	1.00E-00	6.19E-02	6.29E-02	1.10E-00	Estimated
Loggerhead shrike	9.80E-01	0.00E+00	2.00E-02	1.00E-00	1.00E-00	7.44E-03	7.11E-03	4.25E-02	Estimated
Avian carnivores (AV322A)	9.70E-01	0.00E+00	3.00E-02	1.00E-00	1.00E-00	1.73E-02	1.69E-02	1.55E-01	Burrowing owl
Burrowing owl	9.70E-01	0.00E+00	3.00E-02	1.00E-00	1.00E-00	1.73E-02	1.69E-02	1.55E-01	Burrowing owl
Avian carnivores (AV333)	8.20E-01	0.00E+00	1.80E-01	1.00E-00	1.00E-00	1.84E-02	1.81E-02	1.71E-01	Western sandpiper
Avian carnivores (AV342)	9.80E-01	0.00E+00	2.00E-02	1.00E-00	1.00E-00	4.64E-02	4.67E-02	7.06E-01	Not modeled
Avian omnivores (AV422)	6.27E-01	2.80E-01	9.30E-02	1.00E-00	1.00E-00	1.13E-02	1.09E-02	8.02E-02	Wild turkey
Avian omnivores (AV432)	5.70E-01	2.50E-01	1.80E-01	1.00E-00	1.00E-00	2.75E-02	2.73E-02	3.16E-01	Western sandpiper
Avian omnivores (AV433)	5.70E-01	2.50E-01	1.80E-01	1.00E-00	1.00E-00	5.33E-02	5.39E-02	8.74E-01	Western sandpiper

Table 9. (continued).

Functional Groups	PP	PV	PS	SUF	ED	IR (kg/day)	WI (L/day)	BW (kg)	PS Model Species[a]
Avian omnivores (AV442)	6.20E-01	2.70E-01	1.10E-01	1.00E-00	1.00E-00	4.41E-02	4.44E-02	6.54E-01	Wood duck
Mammalian herbivores (M121)	0.00E+00	9.80E-01	2.00E-02	1.00E-00	1.00E-00	3.14E-01	4.82E-01	5.80E-00	Mule deer
Mammalian herbivores (M122)	0.00E+00	9.37E-01	6.30E-02	1.00E-00	1.00E-00	3.30E-03	1.71E-03	1.10E-02	Black-tailed jackrabbit[b]
Mammalian herbivores (M122A)	0.00E+00	9.23E-01	7.70E-02	1.00E-00	1.00E-00	4.27E-03	2.35E-03	1.57E-02	Black-tailed prairie dog
Pygmy rabbit	0.00E+00	9.80E-01	2.00E-02	1.00E-00	1.00E-00	4.53E-02	4.38E-02	4.04E-01	Black-tailed prairie dog
Mammalian herbivores (M123)	0.00E+00	9.23E-01	7.70E-02	1.00E-00	1.00E-00	1.51E-02	1.12E-02	8.89E-02	Black-tailed prairie dog
Mammalian insectivores (M210)	9.80E-01	0.00E+00	2.00E-02	1.00E-00	1.00E-00	1.43E-03	1.43E-03	9.03E-03	Beetle specialist
Mammalian insectivores (M210A)	9.80E-01	0.00E+00	2.00E-02	1.00E-00	1.00E-00	1.43E-03	7.88E-04	4.65E-03	Beetle specialist
Townsend's western big-eared bat	9.90E-01	0.00E+00	1.00E-02	1.00E-00	1.00E-00	2.37E-03	1.71E-03	1.10E-02	Moth specialist
Small-footed myotis	9.90E-01	0.00E+00	1.00E-02	1.00E-00	1.00E-00	1.44E-03	7.94E-04	4.69E-03	Moth specialist
Long-eared myotis	9.90E-01	0.00E+00	1.00E-02	1.00E-00	1.00E-00	1.77E-03	1.09E-03	6.65E-03	Beetle specialist
Mammalian insectivores (M222)	9.76E-01	0.00E+00	2.40E-02	1.00E-00	1.00E-00	1.66E-03	9.91E-04	6.00E-03	Meadow vole
Mammalian carnivores (M322)	9.23E-01	0.00E+00	7.70E-02	1.00E-00	1.00E-00	1.66E-02	2.09E-02	1.78E-01	Black-tailed prairie dog
Mammalian omnivores (M422)	8.06E-01	1.00E-01	9.40E-02	1.00E-00	1.00E-00	3.06E-03	2.53E-03	1.70E-02	Raccoon
Mammalian omnivores (M422A)	8.06E-01	1.00E-01	9.40E-02	1.00E-00	1.00E-00	2.60E-01	4.25E-01	5.05E-00	Fox

Table 9. (continued).

Functional Groups	PP	PV	PS	SUF	ED	IR (kg/day)	WI (L/day)	BW (kg)	PS Model Species[a]
Reptilian insectivores (R222)	9.76E-01	0.00E+00	2.40E-02	1.00E-00	1.00E-00	5.60E-05	0.00E+00	6.61E-03	Meadow vole
Sagebrush lizard	9.76E-01	0.00E+00	2.40E-02	1.00E-00	1.00E-00	5.60E-05	0.00E+00	6.61E-03	Meadow vole
Reptilian carnivores (R322)	9.52E-01	0.00E+00	4.80E-02	1.00E-00	1.00E-00	6.80E-03	0.00E+00	1.50E-02	Fox plus 2%
Plants	0.00E+00	0.00E+00	1.00E-00	1.00E-00	1.00E-00	—	—	—	

a. From Beyer, Conner, and Gerould (1994) unless otherwise noted.

b. Arthur and Gates (1988).

Table 10. Parameter defaults and assumptions for EBSL calculations.

Parameter	EBSL Soil/Sediment Calculations
PV	Herbivores—100 minus PS Insectivores—0 Carnivores—0 Omnivores—PV from literature minus PS/2
PP	Herbivores—0 Insectivores—100 minus PS Carnivores—100 minus PS Omnivores—PP from literature minus PS/2
PS	The highest value (i.e., greatest exposure) was selected from species within functional group. Individual species evaluated using values as presented. (see Table 9)
IR	Allometric equations from Nagy (1987). The largest IR/BW ratio was used from the species within a functional group.
WI	Allometric equations from the *Wildlife Exposure Factors Handbook* (EPA 1993) were used.
BW	The smallest BW/IR ratio was selected from species within each functional group.
ED	Defaulted to 1
SUF	Defaulted to 1

$$EE_{soil/food} = \frac{[(PP \times CP)+(PV \times CV)+(PS \times CS)] \times IR \times ED \times SUF}{BW} \quad (2)$$

where

$EE_{soil/food}$ = estimated exposure from all complete exposure pathways (mg/kg body weight-day)

PP = percentage of diet represented by prey ingested (unitless)

CP = concentration of contaminant in prey item ingested (mg/kg)

PV = percentage of diet represented by vegetation ingested (unitless)

CV = concentration of contaminant in vegetation ingested (mg/kg)

PS = percentage of diet represented by soil ingested (unitless)

CS = concentration of contaminant in soil ingested (mg/kg)

IR = ingestion rate (kg/day), food intake rate (g/day) divided by 1,000 g/kg

ED = exposure duration (fraction of year spent in the affected area) (unitless)

BW = receptor-specific body weight (kg)

SUF = site usage factor (site area divided by home range; cannot exceed 1) (unitless).

The concentration of contaminant in prey can be estimated using the equation (VanHorn, Hampton, and Morris 1995):

$$CP = CS \times BAF \tag{3}$$

where

CP = concentration in prey item ingested (mg/kg)

CS = concentration of contaminant in soil (mg/kg)

BAF = contaminant-specific bioaccumulation factor (unitless).

The concentration of contaminant in vegetation (CV) can be estimated using the equation (VanHorn, Hampton, and Morris 1995):

$$CV = CS \times PUF \tag{4}$$

where

CV = concentration of contaminant in vegetation (mg/kg)

CS = concentration of contaminant in soil (mg/kg)

PUF = contaminant-specific plant uptake factor (unitless).

Contaminant-specific PUFs (from Baes et al. 1984 and other literature sources) and concentration factors (CFs) for calculating EBSLs for metals are presented in the OU 10-04 work plan (DOE-ID 1999). Concentration factors for metals were developed as discussed in the OU 10-04 work plan (DOE-ID 1999). The log of PUF and CFs for organics is estimated using 1.588-0.578 log K_{ow}, and -7.735 + 1.033 log K_{ow}, respectively (Travis and Arms 1988). Log partitioning coefficients (K_{ow}) were taken from the *Groundwater Chemicals Desk Reference* (Montgomery and Welkom 1990).

The exposure equation for exposure of dose in mg/kg body weight-day from surface water ingestion is as follows:

$$EE_{water} = CW * WI \tag{5}$$

where

EE_{water} = estimated intake from ingestion of surface water (mg/kg bodyweight-day)

CW = contaminant concentration in water (mg/L)

WI = water ingestion rate (L/kg bodyweight-day).

Where water ingestion rate is calculated as discussed in Section 2.3.3. Due to the complexity of water ingestion by reptiles, no general reptilian water ingestion equation is available. It is assumed here that desert reptiles, such as those found at the INEEL, get their water solely from prey.

2.1.2 EBSL Calculations

As discussed in detail in Appendix D of the OU 10-04 Work Plan (DOE-ID 1999), the EBSLs for contaminates of concern are useful for quickly screening soil contaminated sites for CERCLA work at the INEEL. The similarity in receptors across the facility makes it possible to develop INEEL-wide screening levels. EBSLs are defined as concentrations of COPCs in soil (or other media) that are not expected to produce adverse effects to selected ecological receptors under chronic exposure conditions. Water ingestion is not included. EBSLs are calculated by inverting the exposure equation. The exposure model estimates the potential intake. In the risk assessment process these intake values are compared to TRVs to evaluate potential effects to receptors. These equations can be manipulated to allow the calculation of a contaminant concentration in a medium that would not be potentially harmful to the receptors with chronic exposure.

To calculate EBSLs for screening against nonradiological soil contamination concentrations, the target hazard quotient (THQ) will be determined. This is defined as a quantitative method for evaluating potential adverse impacts to exposed populations.

$$THQ = \frac{EE_{soil}}{TRV} \tag{6}$$

where

THQ = target hazard quotient (unitless), established at 1.0 for nonradionuclide contaminate exposure

EE_{soil} = estimated exposure from soil (mg/kg body weight-day)

TRV = contaminant-specific toxicity reference value (mg/kg-day).

Thus, solving for the concentration of the nonradionuclide contaminant in the soil (CS) and assuming that when THQ equals 1 that EE_{soil} = TRV. The EBSL for contaminant in the soil is calculated using Equation 7.

$$NR-EBSL_{soil} = \frac{TRV \times BW}{[(PP \times BAF) + (PV \times PUF) + (PS)] \times IR \times ED \times SUF} \tag{7}$$

where

$NR\text{–}EBSL_{soil}$ = INEEL-specific ecological based screening level for non-radionuclide contaminants in soil (mg/kg). (8)

Exposure parameters including dietary composition (percent soil [PS], percent prey [PP], and percent vegetation [PV]), home range, temporal and spatial habitat use data (site use factor [SUF] and ED), soil IR, food IR, body weight (BW), and uptake factors (bioaccumulation factors [BAFs] and plant uptake factors [PUFs]) are input to calculate the EBSL. The input values for calculating EBSLs for each functional group/contaminant combination assume that members of the functional groups are exposed to stressors to the maximum extent, perhaps beyond what is actually expected. For example, it is assumed that a raptor captures 100% of its prey from a contaminated site, and that all the prey are exposed to maximum contaminant concentrations at the site. This is similar to the human risk assessment concept of the "maximally exposed individual," a hypothetical individual who is assumed to live and grow his own food at a location of maximum exposure to a stressor. Each parameter is discussed in more detail in the OU 10-04 Work Plan (DOE-ID 1999). The defaults used in the calculation of EBSLs are presented in Table 10.

2.2 Development of EBSLs for Radionuclide Contaminants

The method used for relating the amount of radiation to specific biological effects is the radiation dose rate, which is a measure of the amount of radiation energy that is dissipated in a given volume of living tissue. Radionuclide exposure can occur from both external contact and internal ingestion. These issues will be presented separately.

2.2.1 Internal Radiation Dose Rate from Soil Exposure

Internal radiation dose rate estimates are calculated by assuming that the steady-state whole body concentration is equivalent to the steady-state concentration of radionuclides in reproductive organs using Equation (9). This is as presented in IAEA (1992).

$$DR_{internal} = \frac{TC \times ED \times SUF \times ADE \times FA \times 3200\ dis/day\text{ - }pCi}{6.24 \times 10^{9}\ MeV/g\text{ - }Gy} \tag{9}$$

where

$DR_{internal}$ = internal radiation dose rate estimate (Gy/day)

TC = tissue radionuclide concentration (pCi/g)

ED = exposure duration (fraction of year spent in affected area) (unitless)

SUF = site use factor (affected area/receptor home range [unitless]; defaulted to 1.0 for EBSL calculation)

ADE = average decay energy per disintegration (MeV/dis)

FA = fraction of decay energy absorbed (unitless).

Since tissue levels of radionuclides are derived by multiplying the concentration of radionuclide in soil by a radionuclide-specific CF for all terrestrial animals or terrestrial plants, the above equation can be rewritten as Equation (10).

$$DR_{internal} = \frac{CS \times CF \times ED \times ADE \times FA \times 3200\ dis/day\text{ - }pCi}{6.24x10^{9}\ MeV/g\text{ - }Gy} \tag{10}$$

where

CS = concentration of contaminant in soil ingested (pCi/g)

CF = concentration factor (unitless).

Solving for the concentration of contaminant in soil (CS) and redefining this concentration as an EBSL, the EBSL for internal consumption of radiological contaminants from contaminated soil media is estimated using Equation (11).

$$EBSL_{internal} = \frac{TRV \times 6.24 \times 10^{9}\ MeV/g\text{-}Gy}{CF \times ED \times ADE \times FA \times 3200\ dis/day\text{-}pCi} \tag{11}$$

where

$EBSL_{internal}$ = internal ecological based screening level for radionuclides in soil (pCi/g)

TRV = toxicity reference value (Gy/day).

Assumptions used in the calculation of the ADE values were for radiations whose energy would be deposited in small tissue volume (ß,a), the FA was set equal to 1. For gamma radiation, the FA was conservatively set equal to 0.3 (30%). This assumption was assumed to be conservative (IAEA 1992). Only radiations with an intensity of 1% or greater were considered, and Auger and conversion electrons were not considered. The ADE values were calculated using Equation (12) (Kocher 1981):

$$ADE = \sum_{i=1}^{n} Y_i\, E_i \tag{12}$$

where

ADE = average decay energy per disintegration (MeV/dis)

Y_i = yield or intensity

E_i = energy of radiation, for ß = average energy.

CFs for radionuclides are discussed in VanHorn, Hampton, and Morris (1995). For EBSL development the CF values for animals are assumed to be 1 for contaminants and receptors unless reported values for CF are larger (in this case the larger CF value is used).

2.2.2 External Radiation

External dose rate EBSLs are derived using formulas outlined in Shleien (1992). Dose rate to tissue in an infinite medium uniformly contaminated by a gamma emitter is calculated by Equation (13).

$$DR_{external} = \frac{2.12 \times ADE \times C}{\rho} \tag{13}$$

where

$DR_{external}$ = external dose rate to tissue (rads/hr)

ADE = average gamma decay energy per disintegration (MeV/dis)

C = concentration of contaminant (μCi/cm^3)

ρ = density of the medium (g/cm^3).

Solving the equation for the concentration in soil assuming an acceptable dose to animals is 1 mGy/day (0.1 rad/day, which is equal to 4.12E-03 rad/hr) (IAEA 1992) and redefining this concentration as an EBSL, the EBSL for external dose from radiological contaminants in soil is estimated using Equation (14).

$$\mathrm{EBSL}_{\mathrm{external}} = \frac{\mathrm{DR}_{\mathrm{external}} \times 10^6\ \mathrm{pCi}/\mu\mathrm{Ci}}{2.12 \times \mathrm{ADE}} \tag{14}$$

where

$EBSL_{external}$ = ecologically based screening level for external exposure to radionuclides in soil (pCi/g)

$DR_{external}$ = external dose rate to tissue (rads/hr)

ADE = average gamma decay energy per disintegration (MeV/dis).

This equation conservatively estimates the dose to burrowing terrestrial functional groups (AV210A, AV222A, M122A, M210A, and M422). This equation also conservatively reflects that these functional groups spend 100% of their time with external exposure. For the nonburrowing functional groups, it is conservatively assumed that they are exposed to 50% (hemisphere) of radiation.

The dose rate for use in the external EBSL calculation is 4.12E-03 rads/hr as discussed above. Contaminant-specific average decay energies and FA values for the radionuclides of concern are presented in VanHorn, Hampton, and Morris (1995).

2.3 Parameter Input Values for EBSLs

EBSLs were calculated using the species-specific input values (PV, PP, PS, IR, WI, BW, ED, SUF) compiled from the literature. Exposures for each functional group or species incorporate best estimates to reflect species-specific life history and feeding habits. These values have been explicitly developed to reflect INEEL contaminant issues. Individual parameter values and literature sources are discussed in the following subsections.

2.3.1 Diet (PV, PP, PS)

Group and individual species diets are represented in the EBSL equations by the sum of three parameters (percent vegetation [PV], percent prey [PP], and percent soil [PS]), constrained to equal 100%. For herbivores, PV is represented by 1 – PS (where PP = 0). No distinction was made between the types of vegetation consumed. Although some primarily herbivorous species may consume a small percent of its diet as insect prey, this was considered in the trophic assignment as part of the functional grouping criteria (VanHorn, Hampton, and Morris 1995).

For carnivores, PP is represented by 1 – PS (where PV = 0). Values for the fraction of overall diet represented by prey were taken from species-specific or representative species diets as reported in the literature.

Dietary composition for omnivores is represented by (PV-PS/2) + (PP-PS/2) + PS = 1 unless PP or PV are 10% or less, in which case, PS was subtracted from the greater of the two. Dietary profiles for functional groups were based on diets for representative species developed from studies conducted at the INEEL and other regional locations. Since most dietary studies report only in terms of prey or vegetation material, the dietary fraction comprised of soil was evenly subtracted from prey and vegetation fractions of the diet to account for inclusion of ingested soil without exceeding 1. The number of individual species comprising prey was not considered. The contribution of prey items to overall diet was based on relative biomass rather than the most numerous individual components. Dietary composition for functional groups is represented by the species having the largest PS within that group.

As shown in Table 9, the values for PS for each functional group were taken primarily from soil ingestion data presented by Beyer, Conner, and Gerould (1994). Species for which values were presented in Beyer, Conner, and Gerould (1994) are limited, so soil ingestion values were assigned using professional judgment to match dietary habits with species most similar to INEEL species represented by functional groups. This selection process is documented in Appendix D2 of the OU 10-04 Work Plan (DOE-ID 1999).

2.3.2 Body Weight (BW)

Body weights (BWs) for mammals, amphibians, and reptiles were extracted from numerous local and regional studies. Body weights for birds were taken primarily from Dunning (1993) unless local or regional values were available. Values were chosen in order of preference for study locale: (1) INEEL, (2) Idaho, (3) Regional (sagebrush steppe in Washington, Oregon, Wyoming, Nevada and northern Utah), and (4) U.S.-wide. Where no distinction in sex was reported, mean adult weights were used. In cases where only separate means for male and female were reported, the average of the two was calculated. In cases where only a range in weights could be found, a median value was used. The basis of the body weight selection used for the functional groups is presented in the OU 10-04 work plan (DOE-ID 1999). Functional group weight represents the smallest individual species body weight in the group.

2.3.3 Food and Water Ingestion Rates (IR, WI)

Food/prey IRs for most INEEL species were calculated using allometric equations given in Nagy (1987). Food intake rates (grams dry weight per day) for passerine birds, nonpasserine birds, rodents, herbivores, all other mammals, and insectivorous reptiles were estimated using the following allometric equations (Nagy 1987).

$$\textit{Food intake rate} = 0.398\ BW^{0.850}\ \textit{(passerines)} \tag{15}$$

$$\textit{Food intake rate} = 1.110\ BW^{0.445}\ \textit{(desert bird)} \tag{16}$$

$$\textit{Food intake rate} = 0.648\ BW^{0.651}\ \textit{(all birds)} \tag{17}$$

$$\textit{Food intake rate} = 0.583\ BW^{0.585}\ \textit{(rodents)} \tag{18}$$

$$\textit{Food intake rate} = 0.577\ BW^{0.727}\ \textit{(mammalian herbivores)} \tag{19}$$

$$\textit{Food intake rate} = 0.235\ BW^{0.822}\ \textit{(all other mammals)} \tag{20}$$

$$\textit{Food intake rate} = 0.15\ BW^{0.874}\ \textit{(desert mammals)} \tag{21}$$

$$\textit{Food intake rate} = 0.013\ BW^{0.773}\ \textit{(reptile insectivores)} \tag{22}$$

where BW = body weight in grams.

An equation for IRs for carnivorous reptiles (R322) was constructed using data reported by Diller and Johnson (1988):

$$\textit{Food intake rate} = 0.01\ BW^{1.6}\ \textit{(reptile carnivores)} \tag{23}$$

where BW = body weight in kilograms.

These equations were applied to estimate the IR (g dry weight/day) as a function of body weight. The application of individual equations for species and groups varies according to taxonomic Class and/or Order and in some cases, habitat (e.g., aquatic species). In cases where more than one of Nagy's (1987) equations could be applied to a functional group, such as all mammals or desert rodents, the larger of the two rates was applied. For functional groups in which mixed species occur, intake rates were calculated using the most representative or generic equation returning the largest IR. Food IRs for functional groups evaluated for the ICDF Complex are presented in Table 10.

Water IRs were calculated for functional groups and individual species using the dry diet allometric equations for birds and mammals (EPA 1993). Reptiles and amphibians were assumed to attain water through absorption and metabolic processes. Although other species (some birds and small mammals) meet water needs through metabolic and dietary means, these species were assumed to ingest water for drinking based on the equations. Allometric equations used in calculating water IRs for individual species and functional groups are presented below.

Water ingestion for individual species was found from the following equations (EPA 1993):

$$WI = 0.059\ BW^{0.67}\ \textit{(for all birds)} \tag{24}$$

$$WI = 0.099\ BW^{0.90}\ \textit{(for all mammals).} \tag{25}$$

Water IRs for functional groups evaluated for the ICDF Complex are presented in Table 10.

2.3.4 Exposure Duration (ED)

Exposure duration (ED) represents the fraction of year an animal spends in the affected area. Because EBSL screening values were designed to be conservative, ED was assumed to be 1 for all receptors, assuming 100% of their time is spent in the assessment area.

2.3.5 Site Use Factor (SUF)

The site use factor (SUF) represents the proportion of a species' home range that overlaps the area of contamination. An SUF of 1 indicates that the home range is less than or equal to the area of contaminant exposure. For EBSL screening, the SUF was assumed to be 1 (100% use occurs in the area of contamination) for all groups and species (see VanHorn, Hampton, and Morris 1995).

2.3.6 Bioaccumulation Factors (BAF, PUF)

The uptake of contaminants in the terrestrial food chain is important for realistically calculating exposure to contamination. These contaminant-specific factors are referred to in the literature as uptake factors or PUFs for plants and food-chain transfer coefficients or factors for wildlife. The PUF is the plant tissue concentration of the contaminant divided by the soil or sediment concentration. The food-chain transfer factor is the animal tissue concentration of a contaminant divided by the concentration in its food. To estimate the tissue levels of contaminants in prey, the PUF was multiplied by the transfer factors to derive a "bioaccumulation factor" (BAF), which is the concentration of a contaminant in the tissues of an animal divided by the soil or sediment concentration. The BAF accounts for all ingestion exposure routes. For example, the BAF for a herbivorous small mammal is the PUF times the plant-to-herbivore transfer coefficient. Multiplying the small mammal BAF times the concentration of a contaminant in soil provides an estimate of the tissue levels of the contaminant in small mammals. This tissue level may then be used to estimate exposure for the carnivore/omnivore functional groups that are predators of small mammals.

BAFs and PUFs developed for the INEEL and used in the calculation of screening level values and EBSLs were defaulted to 1.0 or greater.

2.4 Ecological Effects Assessment

Ecological effects assessment consists of three elements:

- Selecting quantified critical exposure levels (QCELs)
- Developing adjustment factors (AFs)
- Developing TRVs.

The OU 10-04 Work Plan (DOE-ID 1999) contains a general description of the procedures of ecological effects assessment and discussions of the each of the three elements as they apply to the development of TRVs for individual COPCs evaluated.

Information on the toxicological effects on mammalian receptors of the following contaminants was not located. Therefore, these contaminants could not be evaluated for potential risk.

1,1,2-Trichloroethane	2-Nitroaniline	Am-242m
1,1-Dichloroethane	2-Nitrophenol	Am-246
1,1-Dichloroethene	3,3-Dichlorobenzidine	Aramite
1,2-Dichlorobenzene	3-Methyl Butanal	Benzidine
1,2-Dichloroethene (total)	3-Nitroaniline	Benzoic acid
1,4-Dichlorobenzene	4,6-Dinitro-2-methylphenol	Bi-211
2,4,5-Trichlorophenol	4-Bromophenyl-phenylether	bis(2-Chloroethoxy)methane
2,4,6-Trichlorophenol	4-Chloro-3-methylphenol	bis(2-Chloroethyl)ether
2,4-Dichlorophenol	4-Chlorophenyl-phenylether	bis(2-Chloroisopropyl)ether
2,4-Dinitrophenol	4-Methyl-2-Pentanone	bis(2-Ethylhexyl)phthalate
2-Chloronaphthalene	4-Nitroaniline	Bk-249
2-Chlorophenol	4-Nitrophenol	Bk-250
2-Hexanone	Acenaphthylene	Butane,1,1,3,4-Tetrachloro-
2-Methylphenol	Acrolein	Calcium

Carbazole	Heptadecane, 2,6,10,15-Tetra	Octane,2,3,7-Trimethyl
Carbon Disulfide	Hexachlorobenzene	o-Toluenesulfonamide
Cd-113m	Hexachlorobutadiene	Pa-234
Cd-115m	Hexachlorocyclopentadiene	Pb-209
Cf-249	Hexachloroethane	Pb-211
Cf-250	Ho-166m	Pd-107
Cf-251	In-114	Phenol,2,6-Bis(1,1-Dimethyl)
Chloride	In-114m	Phosphorus
Chlorobenzene	In-115	Pm-146
Chloroethane	Iron	Pm-148
Chloromethane	Isobutyl alcohol	Pm-148m
Cm-241	Isophorone	Po-211
Cm-243	Isopropyl Alcohol/2-propanol	Po-213
Cm-245	Kepone	Po-215
Cm-246	Kr-81	Potassium
Cm-247	Manganese	Pr-144m
Cm-250	Mesityl oxide	p-Toluenesulfonamide
Cs-135	Methyl Acetate	Pu-236
Decane, 3,4-Dimethyl	Nb-92	Pu-237
Diacetone alcohol	Nb-95m	Pu-243
Dibenz(a,h)anthracene	Nd-144	Pu-246
Dibenzofuran	Nitrate/Nitrite-N	Ra-222
Dimethyl Disulfide	Nitrite	Ra-223
Dimethylphthalate	N-Nitroso-di-n-propylamine	Rb-87
Dysprosium	N-Nitrosodiphenylamine	Rh-102
Eicosane	Np-235	Rn-218
Ethyl cyanide	Np-236	Rn-219
Eu-150	Np-238	Sb-126
Famphur	Np-240	Sb-126m

Se-79	Tb-160	Th-227
Sm-146	Tc-98	Tl-207
Sm-148	Te-123	Tl-208
Sm-149	Te-123m	Tl-209
Sm-151	Te-127	Tm-171
Sn-121m	Te-127m	Undecane,4,6-Dimethyl-
Sn-123	Te-129	Xe-127
Sn-126	Te-129m	Y-91
Styrene	Terbium	Ytterbium
Sulfide	Th-226	

Information on the toxicological effects on avian receptors of the following contaminants was not located. Therefore these contaminants could not be evaluated for potential risk.

1,1,1-Trichloroethane	2-Chlorophenol	Acetone
1,1,2,2-Tetrachloroethane	2-Hexanone	Acetonitrile
1,1,2-Trichloroethane	2-Methylnaphthalene	Acrolein
1,1-Dichloroethane	2-Methylphenol	Acrylonitrile
1,1-Dichloroethene	2-Nitroaniline	Am-242m
1,2,4-Trichlorobenzene	2-Nitrophenol	Am-246
1,2-Dichlorobenzene	3,3-Dichlorobenzidine	Anthracene
1,2-Dichloroethene (total)	3-Methyl Butanal	Aramite
1,3-Dichlorobenzene	3-Nitroaniline	Aroclor-1260
1,4-Dichlorobenzene	4,6-Dinitro-2-methylphenol	Be-10
1,4-Dioxane	4-Bromophenyl-phenylether	Benzene
2,4,5-Trichlorophenol	4-Chloro-3-methylphenol	Benzidine
2,4,6-Trichlorophenol	4-Chloroaniline	Benzo(a)anthracene
2,4-Dichlorophenol	4-Chlorophenyl-phenylether	Benzo(a)pyrene
2,4-Dimethylphenol	4-Methyl-2-Pentanone	Benzo(b)fluoranthene
2,4-Dinitrophenol	4-Methylphenol	Benzo(g,h,i)perylene
2,4-Dinitrotoluene	4-Nitroaniline	Benzo(k)fluoranthene
2,6-Dinitrotoluene	4-Nitrophenol	Benzoic acid
2-Butanone	Acenaphthene	Bi-210
2-Chloronaphthalene	Acenaphthylene	Bi-211

bis(2-Chloroethoxy)methane
bis(2-Chloroethyl)ether
bis(2-Chloroisopropyl)ether
bis(2-Ethylhexyl)phthalate
Bk-249
Bk-250
Butane,1,1,3,4-Tetrachloro-
Butylbenzylphthalate
C-14
Calcium
Carbazole
Carbon Disulfide
Cd-113m
Cd-115m
Cf-249
Cf-250
Cf-251
Chloride
Chlorobenzene
Chloroethane
Chloromethane
Chrysene
Cm-241
Cm-243
Cm-245
Cm-246
Cm-247
Cm-250
Cs-135
Decane, 3,4-Dimethyl
Diacetone alcohol
Dibenz(a,h)anthracene
Dibenzofuran
Diethylphthalate
Dimethyl Disulfide
Dimethylphthalate
Di-n-butylphthalate
Di-n-octylphthalate
Dysprosium
Eicosane
Ethyl cyanide
Ethylbenzene
Eu-150
Famphur
Fluoranthene
Fluorene
Gd-152
H-3
Heptadecane, 2,6,10,15-Tetra
Hexachlorobenzene
Hexachlorobutadiene
Hexachlorocyclopentadiene
Hexachloroethane
Ho-166m
In-114
In-114m
In-115
Indeno(1,2,3-cd)pyrene
Iron
Isobutyl alcohol
Isophorone
Isopropyl Alcohol/2-propanol
Kepone
Kr-81
Manganese
Mesityl oxide
Methyl Acetate
Methylene Chloride
Naphthalene
Nb-92
Nb-95m
Nd-144
Nitrate/Nitrite-N
Nitrite
Nitrobenzene
N-Nitroso-di-n-propylamine
N-Nitrosodiphenylamine
Np-235
Np-236
Np-238
Np-240
Octane,2,3,7-Trimethyl
o-Toluenesulfonamide
Pa-234
Pb-209
Pb-211
Pd-107
Pentachlorophenol
Phenanthrene
Phenol
Phenol,2,6-Bis(1,1-Dimethyl)
Phosphorus
Pm-146
Pm-147
Pm-148
Pm-148m
Po-210
Po-211
Po-212
Po-213
Po-214
Po-215
Po-216
Po-218
Potassium

Pr-144m
p-Toluenesulfonamide
Pu-236
Pu-237
Pu-241
Pu-243
Pu-246
Pyrene
Ra-222
Ra-223
Ra-228
Rb-87
Rh-102
Rn-218
Rn-219
Ru-106
Sb-126
Sb-126m
Se-79
Sm-146
Sm-147
Sm-148
Sm-149
Sm-151
Sn-121m
Sn-123
Sn-126
Sr-90
Strontium
Styrene
Sulfide
Tb-160
Tc-98
Te-123
Te-123m
Te-127
Te-127m
Te-129
Te-129m
Terbium
Tetrachloroethene
Th-226
Th-227
Tl-207
Tl-208
Tl-209
Tm-171
Toluene
Tributylphosphate
Trichloroethene
Undecane,4,6-Dimethyl-
Xe-127
Xylene (ortho)
Xylene (total)
Y-91
Ytterbium
Zirconium
Zr-93

3. SCREENING APPROACH

The EBSL screening is the first step in the SLERA approach. The SLERA will evaluate both the evaporation pond and landfill as is shown in Figures 5 and 6. Figure 5 presents the risk assessment approach used to evaluate the COPCs. This is primarily identifying those COPCs that are solely soil contaminant issues and those for which associated leachate concentration have been identified (see Tables 1–3). Those COPCs that are strictly identified as being restricted to the landfill are addressed as presented in Figure 7.

The evaluation of the radiological contaminants of potential concern is presented in Figure 6. There are only three radionuclides for which both soil and water concentrations are identified by EDF-ER-264 and EDF-ER-274. These are I-129, Tc-99, and U-238. These three radiological COPCs will be evaluated using the Biotic Dose Assessment Methodology as discussed below.

3.1 Screening of Contaminants of Potential Concern

Tables 11 through 14 compare modeled concentrations of contaminant in soil and water to EBSLs and Biotic Dose Assessment values (DOE-ID 2000) for the COPCs and radiological COPCs identified at the ICDF landfill and evaporation pond. Concentrations for soil at each level of screening and assessment were developed as presented in Figure 7. In Tables 11 through 14, a highlighted concentration value for a COPC indicates that the contaminant was brought forward in the assessment.

3.1.1 Initial Screening in Soil

The initial screening was based on the maximum contaminant masses presented in the Design Inventory (EDF-ER-264). The maximum mass of each COPC (totaled for all sites) was divided by the volume capacity of the ICDF landfill (389,000 m^3) to yield the concentration (mg/kg) assumed throughout the entire landfill. This value was compared to the background soil concentrations at the INEEL (Rood, Harris, and White 1995). If the values were below background concentrations they were eliminated from further consideration. COPCs were then compared to screening criteria. COPCs that were above screening criteria were brought forward to the next level of screening.

The maximum activity of each radiological COPC (totaled for all sites) was divided by the volume capacity of the ICDF landfill (318,000 m^3) to yield the pCi/g of radiological COPC through the entire landfill.

The concentrations were compared to screening criteria or BDAC values. Radiological COPCs with concentrations above screening criteria were brought forward as potential concerns to the next level of screening.

To ensure that possible cumulative effects from multiple contaminants are accounted for, a total screening level quotient or hazard index will be calculated at each step of the process. The advantages of using this approach during the EBSL/BDAC screening are that it allows the summation of effects, the determination of relative risk from the contaminants under consideration, and the propagation of higher-risk contaminants through to more detailed risk assessment, while dropping those with low risk. For the initial screening step, a screening level hazard quotient (SLQ) was calculated. Calculation of the SLQ is the maximum concentration divided by the EBSL. The SLQs were then summed across the pathways by functional group and/or T/E species to calculate a total screening level quotient (TSLQ). A TSLQ less than 1.0 for nonradionuclide COPCs and 0.1 for radionuclide COPCs would indicate that no risk is apparent.

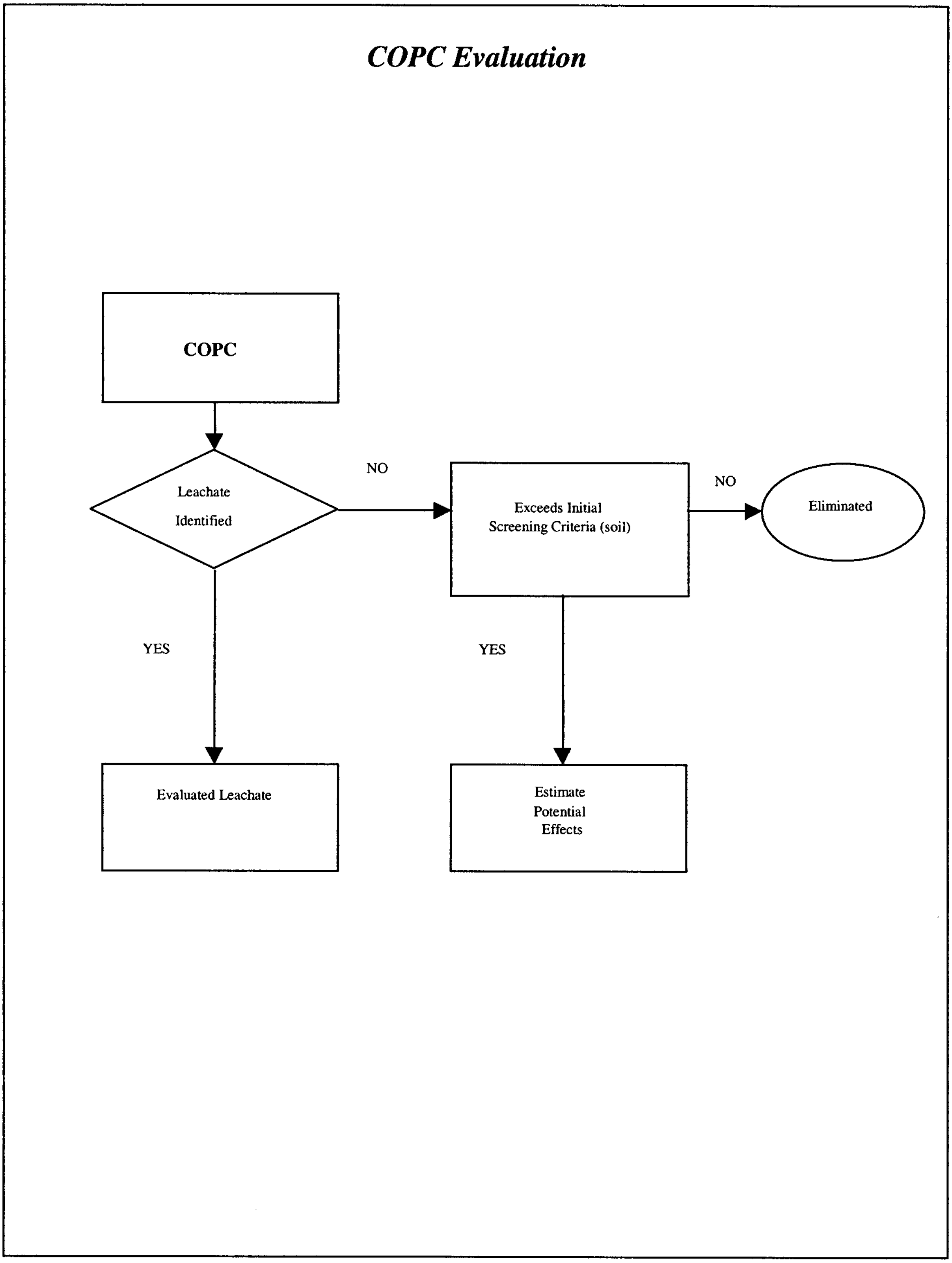

Figure 5. Evaluation process for COPCs identified as present in soil and leachate.

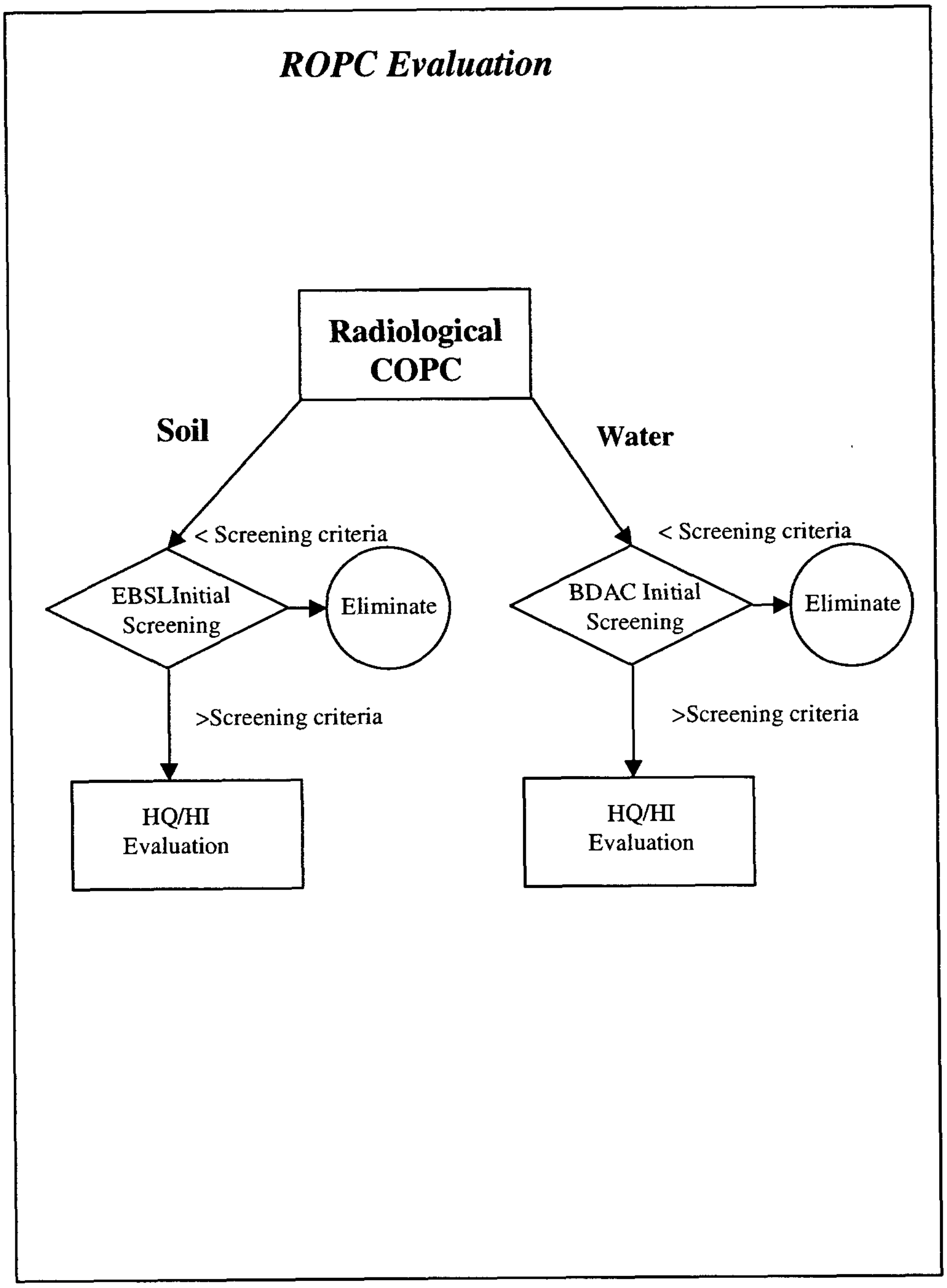

Figure 6. Evaluation process for radiological COPCs identified as present in soil and leachate.

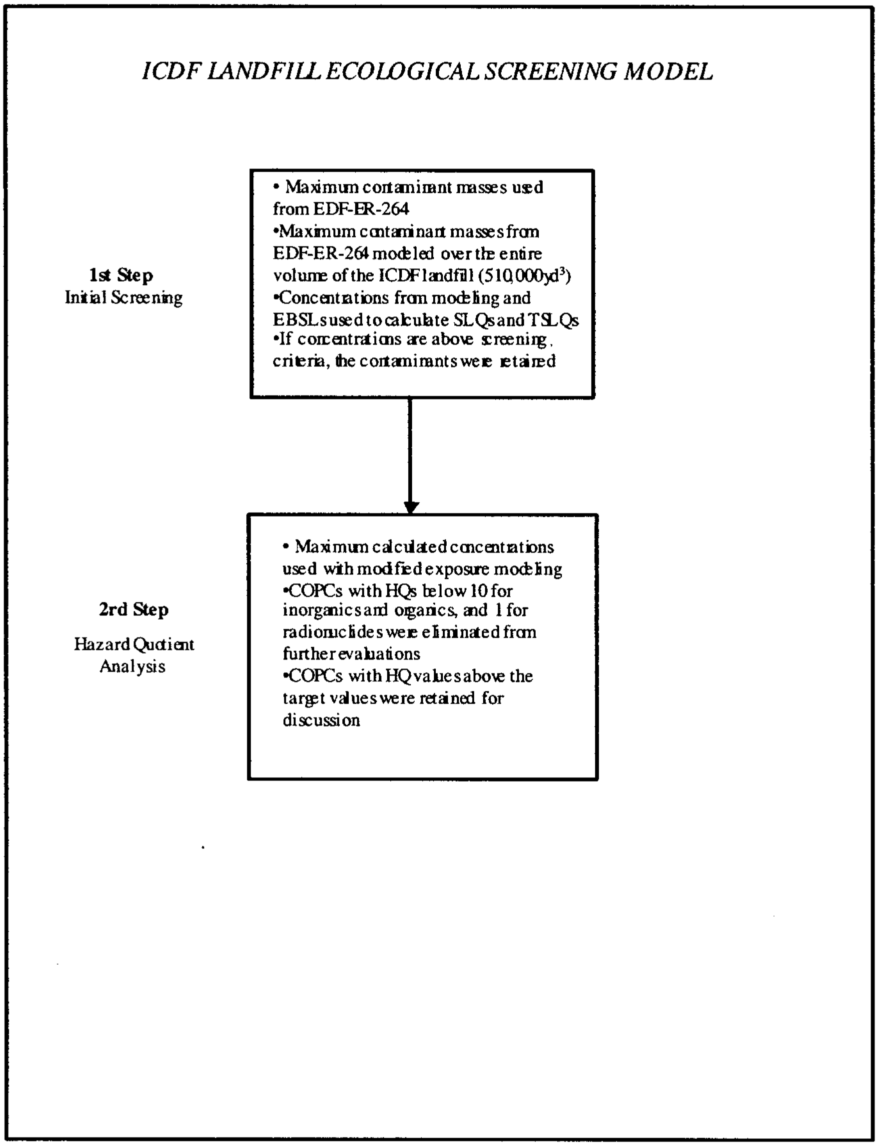

Figure 7. IDCF landfill ecological risk assessment soil screening process.

3.1.1.1 Initial Screening for Organic Contaminants in Soil. Table 11 presents the initial screening for organic contaminants in soil. Those COPCs brought forward to HQ analysis are acetone, aroclor-1254, pentachlorophenol, and xylene.

3.1.1.2 Initial Screening for Inorganic Contaminants in Soil. Table 12 presents the initial screening for inorganic contaminants in soil. Those COPCs brought forward to HQ analysis are boron, copper, cyanide, fluoride, lead, mercury (inorganic), molybdenum, nitrate, selenium, silver, strontium, sulfate, zinc, and zirconium.

3.1.1.3 Initial Screening for Radiological Contaminants in Soil. Table 13 presents the initial screening of **radiological** COPCs in soil. The following radiological contaminants were brought forward to assess their cumulative effects on receptors: Am-241, Ba-137m, Cs-137, Eu-152, Eu-154, Pu-238, Pu-239, Sr-90, Kr-85.

3.1.1.4 Initial Screening for Radiological Contaminants in Water. The DOE (headquarters) has recently developed frameworks, methods and guidance for demonstrating protection of the environment from the effects of ionizing radiation. This proposed standard is called A Graded Approach for Evaluating Radiation Doses to Aquatic and Terrestrial Biota (DOE, in preparation). It is approved by EH-4 for interim use by DOE program and field elements in evaluating doses to biota. A graded approach for evaluating doses to biota was developed using an interdisciplinary team approach through a DOE-sponsored Biota Dose Assessment Committee. A three-phased process was provided: (1) defining the evaluation area and assembling radionuclide concentration data; (2) applying an easy-to-use general screening methodology that provides limiting radionuclide concentration values (Biota Concentration Guides, BCGs) for radionuclides in soil, sediment and water; and, if needed, (3) conducting site-specific analysis using site-representative parameters in place of default values, a kinetic/allometric modeling tool, or an actual site-specific biota dose assessment involving the collection of biota within an eco-risk framework. This technical standard provides dose evaluation methods that can be used to meet the requirements of DOE Orders 5400.1 and 5400.5.

The DOE standard provides a general screening that allows the concentrations of radionuclides in water, co-located sediments, and soils to be evaluated for both the aquatic and terrestrial system. For those radiological COPCs that have both leachate and soil concentration, this approach was used. It is well accepted that sediment and water contaminant concentrations will come to equilibrium within a system. For this analysis it is not appropriate to calculate a sediment concentration from the water since this will be the leachate concentration estimated over 15 years of operation. Therefore, for this assessment, the water concentration summed over all years of operation is considered conservative of the dose that receptors using the pond would receive. Generic Biotic Concentration Guides (BCGs) are used within each system. A sum of fractions approach is used in comparing radionuclide concentrations in environmental media with the BCGs contained in the standard lookup tables. When multiple radionuclides are present in multiple environmental media, the sum of fractions rule should be applied to account for all sources of exposure. Hence, the sum of the ratios of the concentration for each radionuclide to its corresponding BCG for each medium should then be summed across media, and the total sum of fractions should not exceed 1.0.

3.1.1.5 Summary of Initial Screening. All organic and inorganic COPCs were analyzed for their cumulative effect on receptors. A TSLQ evaluation was performed to ensure that organic COPCs contributing to accumulated risk were brought forward in the analysis (Tables 11 and 12 present the SLQs for avian and mammalian receptors as well as the COPCs percent contribution to risk). Based on evaluation of the percent contribution to the FSLQ, any COPC contributing 2.5% or greater to the TSLQ was retained for further assessment unless eliminated as presented in Tables 11 and 12. Inorganic COPCs with maximum calculated concentrations below background concentrations were eliminated from further consideration. Those COPCs brought forward to HQ analysis are acetone, aroclor-1254, boron, copper, cyanide, fluoride, lead, mercury (inorganic), molybdenum, nitrate, pentachlorophenol, selenium, silver, strontium, sulfate, xylene, zinc, and zirconium.

All radiological COPCs were analyzed for their cumulative effect on receptors. A TSLQ evaluation was performed to ensure that radiological COPCs contributing to accumulated risk were considered (Table 13 presents the SLQs for internal and external as well as the COPC's percent contribution to risk). Any radiological COPC within 0.25 of an EBSL was brought to the next step (HQ analysis) due to multiple contamination. The following radiological contaminants were brought forward to assess their cumulative effects on receptors: Am-241, Cs-137, Eu-152, Eu-154, Pu-238, Pu-239, Sr-90, Kr-85.

Table 11. Initial EBSL screening for organic contaminants for soil against the maximum contaminant concentration.

COPC	Maximum Contaminant Mass (kg) from EDF-ER-264	Maximum Calculated Concentration (mg/kg)	Minimum EBSL for Avian	Minimum EBSL for Mammalian	SLQs for Avian	SLQs for Mammalian	%Avian[a]	%Mammalian[a]	Plant Benchmark
1,1,1-Trichloroethane	7.40E+00	1.27E-02	NA	8.13E+02	NA	1.56E-05	NA	0.00%	NA
1,1,2,2-Tetrachloroethane	2.30E-02	3.94E-05	NA	1.67E+01	NA	2.36E-06	NA	0.00%	NA
1,2,4-Trichlorobenzene	5.40E+00	9.26E-03	NA	1.82E+00	NA	5.09E-03	NA	0.04%	NA
1,2-Dichloroethane	2.50E-03	4.29E-06	1.39E+00	1.11E+01	3.09E-06	3.86E-07	0.00%	0.00%	NA
1,3-Dichlorobenzene	5.40E+00	9.26E-03	NA	7.82E-02	NA	1.18E-01	NA	0.97%	NA
1,4-Dioxane	8.90E-03	1.53E-05	NA	1.58E-02	NA	9.68E-04	NA	0.01%	NA
2,4-Dimethylphenol	8.60E+00	1.47E-02	NA	3.75E+01	NA	3.92E-04	NA	0.00%	NA
2,4-Dinitrotoluene	5.40E+00	9.26E-03	NA	1.54E+00	NA	6.01E-03	NA	0.05%	NA
2,6-Dinitrotoluene	9.80E+00	1.68E-02	NA	2.18E+00	NA	7.71E-03	NA	0.06%	NA
2-Butanone	1.20E+01	2.06E-02	NA	3.83E+01	NA	5.38E-04	NA	0.00%	NA
2-Methylnaphthalene	2.40E+02	4.12E-01	NA	A	NA	NA	NA	NA	NA
4-Chloroaniline	1.90E+01	3.26E-02	NA	5.35E-01	NA	6.09E-02	NA	0.50%	NA
4-Methylphenol	1.80E+01	3.09E-02	NA	4.92E+00	NA	6.28E-03	NA	0.05%	NA
Acenaphthene	9.60E+01	1.65E-01	NA	4.74E+01	NA	3.48E-03	NA	0.03%	NA
Acetone	2.90E+02	4.97E-01	NA	5.53E-01	NA	8.99E-01	NA	7.36%	NA
Acetonitrile	8.90E-03	1.53E-05	NA	3.08E-01	NA	4.97E-05	NA	0.00%	NA
Acrylonitrile	4.30E-03	7.37E-06	NA	1.15E-02	NA	6.41E-04	NA	0.01%	NA
Anthracene	1.50E+02	2.57E-01	NA	1.35E+02	NA	1.90E-03	NA	0.02%	NA
Aroclor-1016	3.60E+00	6.17E-03	c	c	NA	NA	NA	NA	b
Aroclor-1254	6.10E+01	1.05E-01	1.66E-01	3.57E-01	0.63253	2.94E-01	100.00%	2.41%	40
Aroclor-1260	3.40E+02	5.83E-01	NA	8.02E+00	NA	7.27E-02	NA	0.60%	40
Aroclor-1268	2.90E+01	4.97E-02	c	c	NA	NA	NA	NA	b

Table 11. (continued).

COPC	Maximum Contaminant Mass (kg) from EDF-ER-264	Maximum Calculated Concentration (mg/kg)	Minimum EBSL for Avian	Minimum EBSL for Mammalian	SLQs for Avian	SLQs for Mammalian	%Avian[a]	%Mammalian[a]	Plant Benchmark
Benzene	2.90E+02	4.97E-01	NA	5.50E+00	NA	9.04E-02	NA	0.74%	NA
Benzo(a)anthracene	1.20E+02	2.06E-01	NA	3.02E+01	NA	6.82E-03	NA	0.06%	NA
Benzo(a)pyrene	5.00E+01	8.57E-02	NA	2.69E+00	NA	3.19E-02	NA	0.26%	NA
Benzo(b)fluoranthene	8.50E+01	1.46E-01	NA	B	NA	NA	NA	NA	NA
Benzo(g,h,i)perylene	5.40E+00	9.26E-03	NA	b	NA	NA	NA	NA	NA
Benzo(k)fluoranthene	8.80E+00	1.51E-02	NA	b	NA	NA	NA	NA	NA
Butylbenzylphthalate	3.20E+01	5.49E-02	NA	1.43E+01	NA	3.84E-03	NA	0.03%	NA
Chrysene	1.30E+02	2.23E-01	NA	b	NA	NA	NA	NA	NA
Diethylphthalate	5.40E+00	9.26E-03	NA	1.53E+02	NA	6.05E-05	NA	0.00%	NA
Di-n-butylphthalate	1.10E+01	1.89E-02	NA	1.50E+01	NA	1.26E-03	NA	0.01%	200
Di-n-octylphthalate	1.20E+01	2.06E-02	NA	4.71E+01	NA	4.37E-04	NA	0.00%	NA
Ethylbenzene	3.70E+01	6.34E-02	NA	5.52E+01	NA	1.15E-03	NA	0.01%	NA
Fluoranthene	3.60E+02	6.17E-01	NA	3.38E+01	NA	1.83E-02	NA	0.15%	NA
Fluorene	8.70E+01	1.49E-01	NA	3.38E+01	NA	4.41E-03	NA	0.04%	NA
Indeno(1,2,3-cd)pyrene	5.40E+00	9.26E-03	NA	b	NA	NA	NA	NA	NA
Methylene Chloride	4.00E+01	6.86E-02	NA	1.00E+00	NA	6.86E-02	NA	0.56%	NA
Naphthalene	2.00E+02	3.43E-01	NA	1.43E+00	NA	2.40E-01	NA	1.97%	NA
Nitrobenzene	5.40E+00	9.26E-03	NA	1.96E+00	NA	4.72E-03	NA	0.04%	NA
Pentachlorophenol	2.60E+01	4.46E-02	NA	1.30E-01	NA	3.43E-01	NA	2.81%	NA
Phenanthrene	5.50E+02	9.43E-01	NA	1.35E+02	NA	6.99E-03	NA	0.06%	NA
Phenol	3.80E+01	6.52E-02	NA	8.23E+00	NA	7.92E-03	NA	0.06%	70
Pyrene	1.20E+02	2.06E-01	NA	4.20E+01	NA	4.90E-03	NA	0.04%	NA
Tetrachloroethene	4.60E+00	7.89E-03	NA	3.33E+00	NA	2.37E-03	NA	0.02%	NA

Table 11. (continued).

COPC	Maximum Contaminant Mass (kg) from EDF-ER-264	Maximum Calculated Concentration (mg/kg)	Minimum EBSL for Avian	Minimum EBSL for Mammalian	SLQs for Avian	SLQs for Mammalian	%Avian[a]	%Mammalian[a]	Plant Benchmark
Toluene	4.70E+02	8.06E-01	NA	6.04E+01	NA	1.33E-02	NA	0.11%	NA
Tributylphosphate	1.70E+02	2.91E-01	NA	3.99E+01	NA	7.29E-03	NA	0.06%	NA
Trichloroethene	3.40E+01	5.83E-02	NA	1.74E+01	NA	3.35E-03	NA	0.03%	NA
Xylene (ortho)	1.80E+00	3.09E-03	NA	2.78E-01	NA	1.11E-02	NA	0.09%	NA
Xylene (total)	1.60E+03	2.74E+00	NA	2.78E-01	NA	9.86E+00	NA	80.75%	NA
Total SLQ					6.30E-01	1.22E+01	100.00%	100.00%	

a. % values for avian or mammalian are the SLQ for each COPC divided by the total SLQ

b. Values for benzo(a)pyrene used.

c. Values for Aroclor-1254 used.

Note: Highlighting of a value indicates that COPC was retained for further analysis.

Table 12. Initial EBSL screening for inorganic contaminants maximum calculated concentration in soil against the maximum contaminant concentrations from Table 2.

COPC	Maximum Contaminant Mass (kg) from EDF-ER-264	Maximum Calculated Concentration (mg/kg)	Background Soil Concentrations (mg/kg)	Below Background Soil Concentrations	Minimum EBSL for Avian	Minimum EBSL for Mammalian	Plant Benchmark	SLQ for Avian	SLQ for Mammalian	%Avian[a]	%Mammalian[a]
Aluminum[b]	3.40E+06	5.83E+03	1.60E+04	Yes	1.55E+02	8.50E+00	50	3.76E+01	6.86E+02	8.07%	28.36%
Antimony	2.80E+03	4.80E+00	4.80E+00	Yes	NA	1.35E+00	5	NA	3.56E+00	NA	0.15%
Arsenic	2.70E+03	4.63E+00	5.80E+00	Yes	1.28E+00	8.44E-01	10	3.62E+00	5.49E+00	0.78%	0.23%
Barium	8.50E+04	1.46E+02	3.00E+02	Yes	NA	1.10E+01	500	NA	1.33E+01	NA	0.55%
Beryllium	1.40E+02	2.40E-01	1.80E+00	Yes	NA	7.14E-01	10	NA	3.36E-01	NA	0.01%
Boron	8.70E+04	1.49E+02	NA	No	9.25E+00	2.56E+00	0.5	1.61E+01	5.82E+01	3.45%	2.41%
Cadmium[c]	1.70E+03	2.91E+00	2.20E+00	No	3.83E-02	2.36E-03	3	7.60E+01	1.23E+03	16.29%	50.98%
Calcium[b]	9.70E+06	1.66E+04	2.40E+04	Yes	NA	NA	NA	NA	NA	NA	NA
Chromium III	1.90E+04	3.26E+01	3.30E+01	Yes	2.82E+00	8.11E+02	1	1.16E+01	4.02E-02	2.48%	0.00%
Cobalt	2.90E+03	4.97E+00	1.10E+01	Yes	4.35E-01	4.27E-01	NA	1.14E+01	1.16E+01	2.45%	0.48%
Copper	1.40E+04	2.40E+01	2.20E+01	No	9.54E+00	2.11E+00	100	2.52E+00	1.14E+01	0.54%	0.47%
Cyanide	1.60E+02	2.74E-01	NA	No	1.43E-01	5.84E+00	NA	1.92E+00	4.69E-02	0.41%	0.00%
Fluoride	1.80E+03	3.09E+00	NA	No	2.69E+00	3.40E+01	NA	1.15E+00	9.09E-02	0.25%	0.00%
Iron[b]	4.90E+06	8.40E+03	2.40E+04	Yes	NA	NA	NA	NA	NA	NA	NA
Lead	2.70E+04	4.63E+01	1.70E+01	No	9.94E-01	8.76E+00	50	4.66E+01	5.29E+00	9.99%	0.22%
Magnesium[b]	2.10E+06	3.60E+03	1.20E+04	Yes	1.86E+01	1.05E+01	500	1.94E+02	3.43E+02	41.50%	14.18%
Manganese	9.80E+04	1.68E+02	4.90E+02	Yes	NA	NA	NA	NA	NA	NA	NA
Mercury (inorganic)	4.50E+03	7.72E+00	NA	No	4.18E+00	3.57E-01	0.3	1.85E+00	2.16E+01	0.40%	0.89%
Molybdenum	4.80E+03	8.23E+00	NA	No	NA	1.07E+01	2	NA	7.69E-01	NA	0.03%
Nickel	9.30E+03	1.59E+01	3.50E+01	Yes	6.83E+01	6.17E+01	30	2.33E-01	2.58E-01	0.05%	0.01%
Nitrate	1.90E+03	3.26E+00	NA	No	1.84E+01	5.52E+01	NA	1.77E-01	5.91E-02	0.04%	0.00%
Potassium[b]	5.30E+05	9.09E+02	4.30E+03	Yes	NA	NA	NA	NA	NA	NA	NA
Selenium	4.00E+02	6.86E-01	2.20E-01	No	1.72E-01	4.22E-01	1	3.99E+00	1.63E+00	0.86%	0.07%
Silver	4.70E+03	8.06E+00	NA	No	3.02E+01	3.67E+01	2	2.67E-01	2.20E-01	0.06%	0.01%
Sodium[b]	1.00E+05	1.71E+02	3.20E+02	Yes	NA	NA	NA	NA	NA	NA	NA

Table 12. (continued).

COPC	Maximum Contaminant Mass (kg) from EDF-ER-264	Maximum Calculated Concentration (mg/kg)	Background Soil Concentrations (mg/kg)	Below Background Soil Concentrations	Minimum EBSL for Avian	Minimum EBSL for Mammalian	Plant Benchmark	SLQ for Avian	SLQ for Mammalian	%Avian[a]	%Mammalian[a]
Strontium	8.60E+03	1.47E+01	NA	No	NA	5.91E+00	NA	NA	2.49E+00	NA	0.10%
Sulfate	9.70E+03	1.66E+01	NA	No	1.78E+01	1.72E+01	NA	9.33E-01	9.65E-01	0.20%	0.04%
Thallium	1.80E+02	3.09E-01	4.30E-01	Yes	1.01E-01	1.30E-01	1	3.06E+00	2.38E+00	0.66%	0.10%
Vanadium	1.00E+04	1.71E+01	4.50E+01	Yes	7.87E+00	1.49E+00	200	2.17E+00	1.15E+01	0.47%	0.47%
Zinc	9.90E+04	1.70E+02	1.50E+02	No	3.29E+00	3.18E+01	50	5.17E+01	5.35E+00	11.08%	0.22%
Zirconium	3.30E+04	5.66E+01	NA	No	NA	3.23E+02	NA	NA	1.75E-01	NA	0.01%
Total SLQ								4.66E+02	2.42E+03	*100.00%*	*100.00%*

a. % values for avian or mammalian are the SLQ for each COPC divided by the total SLQ

b. Six metals (aluminum, calcium, iron, magnesium, potassium, and sodium) are routinely eliminated as essential elements unless the concentration quantity exceeds background (10x).

c. Cadmium was eliminated from the analysis. EPA (2000) found that levels of 29 mg/kg for plants and 110 mg/kg for soil invertebrates are acceptable. Cadmium availability is highly dependent on pH and chemical speciation. It is not anticipated to be a problem under our site-situation.

Note: Highlighting of a value indicates that the COPC was retained for future evaluation.

Table 13. Initial EBSL screening for radiological contaminants in soil using the maximum concentration from Table 3.

COPC	Maximum Concentration from EDF-ER-264 (pCi/g)	External Dose EBSL	Internal Dose EBSL	SLQ for External	SLQ for Internal	%External[b]	%Internal[b]
Ac-225	4.11E-08	2.92E+05	1.70E+01	1.41E-13	2.42E-09	0.00%	0.00%
Ac-227	1.66E-05	2.40E+07	2.04E+05	6.92E-13	8.14E-11	0.00%	0.00%
Ac-228	1.23E-10	3.29E+03	3.10E+03	3.74E-14	3.97E-14	0.00%	0.00%
Ag-108	3.08E-09	1.82E+03	1.78E+03	1.69E-12	1.73E-12	0.00%	0.00%
Ag-108m	6.51E-01	1.82E+03	4.01E+03	3.58E-04	1.62E-04	0.00%	0.00%
Ag-109m	3.94E-12	9.01E+05	1.99E+06	4.37E-18	1.98E-18	0.00%	0.00%
Ag-110	4.28E-11	1.06E+03	9.37E+02	4.04E-14	4.57E-14	0.00%	0.00%
Ag-110m	4.45E-09	1.08E+03	2.20E+03	4.12E-12	2.02E-12	0.00%	0.00%
Am-241	1.88E+01	1.32E+05	1.78E+01	1.42E-04	1.06E+00	0.00%	4.34%
Am-242	3.60E-05	1.66E+05	5.32E+02	2.17E-10	6.77E-08	0.00%	0.00%
Am-243	2.74E-04	5.70E+04	1.85E+01	4.81E-09	1.48E-05	0.00%	0.00%
At-217	4.11E-08	1.24E+07	1.38E+01	3.31E-15	2.98E-09	0.00%	0.00%
Ba-137m	1.88E+04	4.95E+03[a]	1.09E+04[a]	3.80E+00	1.72E+00	43.40%	7.08%
Be-10	9.25E-07	NA	9.63E+03	NA	9.61E-11	NA	0.00%
Bi-210	8.90E-07	NA	5.01E+03	NA	1.78E-10	NA	0.00%
Bi-212	4.45E-04	1.23E+03	6.66E+02	3.62E-07	6.68E-07	0.00%	0.00%
Bi-214	4.62E-06	1.99E+03	3.83E+03	2.32E-09	1.21E-09	0.00%	0.00%
C-14	3.77E-05	NA	3.94E+04	NA	9.57E-10	NA	0.00%
Cd-109	3.94E-12	1.98E+05	4.36E+05	1.99E-17	9.04E-18	0.00%	0.00%
Ce-141	1.46E-71	4.22E+04	1.18E+04	3.46E-76	1.24E-75	0.00%	0.00%
Ce-144	1.47E-03	1.87E+05	2.27E+04	7.86E-09	6.48E-08	0.00%	0.00%
Cf-252	1.88E-20	1.45E+08	1.64E+01	1.30E-28	1.15E-21	0.00%	0.00%
Cm-242	4.45E-17	1.24E+08	1.60E+01	3.59E-25	2.78E-18	0.00%	0.00%
Cm-244	1.46E-03	2.30E+08	1.68E+01	6.35E-12	8.69E-05	0.00%	0.00%
Cm-248	1.59E-16	3.35E+08	2.10E+01	4.75E-25	7.57E-18	0.00%	0.00%
Co-57	2.91E-03	2.45E+04	5.40E+04	1.19E-07	5.39E-08	0.00%	0.00%
Co-58	4.79E-17	3.66E+03	7.17E+03	1.31E-20	6.68E-21	0.00%	0.00%
Co-60	1.58E+02	1.18E+03	1.12E+03	1.34E-01	1.41E-01	1.53%	0.58%
Cr-51	1.88E-54	9.39E+04	2.07E+05	2.00E-59	9.08E-60	0.00%	0.00%
Cs-134	9.08E+00	1.90E+03	3.14E+03	4.78E-03	2.89E-03	0.05%	0.01%
Cs-137	2.05E+04	4.95E+03	5.58E+03	4.14E+00	3.67E+00	47.33%	15.08%
Eu-152	7.88E+02	2.27E+03	2.18E+03	3.47E-01	3.61E-01	3.97%	1.48%
Eu-154	6.68E+02	2.48E+03	3.31E+03	2.69E-01	2.02E-01	3.08%	0.83%
Eu-155	1.44E+02	5.95E+04	3.25E+04	2.42E-03	4.43E-03	0.03%	0.02%
Fe-59	3.60E-35	2.48E+03	4.12E+03	1.45E-38	8.74E-39	0.00%	0.00%
Fr-221	4.11E-08	8.98E+04	1.53E+01	4.58E-13	2.69E-09	0.00%	0.00%
Fr-223	2.23E-07	5.85E+04	5.47E+03	3.81E-12	4.08E-11	0.00%	0.00%
Gd-152	2.23E-14	NA	4.53E+01	NA	4.92E-16	NA	0.00%
Gd-153	1.63E-11	5.32E+04	1.17E+05	3.06E-16	1.39E-16	0.00%	0.00%
H-3	3.94E+01	NA	3.43E+05	NA	1.15E-04	NA	0.00%
Hf-181	6.34E-37	5.69E+03	7.12E+03	1.11E-40	8.90E-41	0.00%	0.00%
I-129	1.04E+00	9.88E+05	4.76E+04	1.05E-06	2.18E-05	0.00%	0.00%
Kr-85	9.42E+02	1.88E+04	3.70E+03	5.01E-02	2.55E-01	0.57%	1.05%

Table 13. (continued).

COPC	Maximum Concentration from EDF-ER-264 (pCi/g)	External Dose EBSL	Internal Dose EBSL	SLQ for External	SLQ for Internal	%External[b]	%Internal[b]
La-140	2.23E-105	1.43E+03	1.67E+03	1.56E-108	1.34E-108	0.00%	0.00%
Mn-54	1.56E-08	3.53E+03	7.79E+03	4.42E-12	2.00E-12	0.00%	0.00%
Nb-93m	1.10E-02	1.51E+06	3.33E+06	7.28E-09	3.30E-09	0.00%	0.00%
Nb-94	7.19E-06	1.87E+03	3.14E+03	3.84E-09	2.29E-09	0.00%	0.00%
Nb-95	3.94E-33	3.56E+03	6.69E+03	1.11E-36	5.89E-37	0.00%	0.00%
Np-237	5.14E-01	1.46E+05	1.94E+01	3.52E-06	2.65E-02	0.00%	0.11%
Np-239	2.74E-04	1.71E+04	1.17E+04	1.60E-08	2.34E-08	0.00%	0.00%
Np-240m	2.05E-11	8.83E+03	2.83E+03	2.32E-15	7.24E-15	0.00%	0.00%
Pa-231	5.65E-05	9.89E+04	2.37E+01	5.71E-10	2.38E-06	0.00%	0.00%
Pa-233	3.60E-02	1.90E+04	1.70E+04	1.89E-06	2.12E-06	0.00%	0.00%
Pa-234m	1.39E-03	2.58E+05	2.37E+03	5.39E-09	5.86E-07	0.00%	0.00%
Pb-210	8.90E-07	1.57E+06	2.74E+05	5.67E-13	3.25E-12	0.00%	0.00%
Pb-212	4.45E-04	2.53E+04	1.45E+04	1.76E-08	3.07E-08	0.00%	0.00%
Pb-214	4.62E-06	1.29E+04	6.78E+03	3.58E-10	6.81E-10	0.00%	0.00%
Pm-147	3.08E+02	NA	3.15E+04	NA	9.78E-03	NA	0.04%
Po-210	8.22E-07	NA	1.84E+01	NA	4.47E-08	NA	0.00%
Po-212	2.74E-04	NA	1.11E+01	NA	2.47E-05	NA	0.00%
Po-214	4.62E-06	NA	1.27E+01	NA	3.64E-07	NA	0.00%
Po-216	4.45E-04	NA	1.44E+01	NA	3.09E-05	NA	0.00%
Po-218	4.62E-06	NA	1.62E+01	NA	2.85E-07	NA	0.00%
Pr-144	1.44E-03	2.86E+05	1.61E+03	5.03E-09	8.94E-07	0.00%	0.00%
Pu-238	1.88E+02	1.13E+05	1.78E+01	1.66E-03	1.06E+01	0.02%	43.36%
Pu-239	5.48E+00	2.66E+06	1.89E+01	2.06E-06	2.90E-01	0.00%	1.19%
Pu-240	1.22E+00	1.94E+06	1.89E+01	6.29E-07	6.46E-02	0.00%	0.27%
Pu-241	5.14E+01	NA	3.73E+05	NA	1.38E-04	NA	0.00%
Pu-242	1.88E-04	2.34E+06	2.00E+01	8.03E-11	9.40E-06	0.00%	0.00%
Pu-244	2.05E-11	2.70E+06	2.12E+01	7.59E-18	9.67E-13	0.00%	0.00%
Ra-224	4.45E-04	3.11E+05	2.56E+01	1.43E-09	1.74E-05	0.00%	0.00%
Ra-225	4.11E-08	2.54E+05	2.00E+04	1.62E-13	2.06E-12	0.00%	0.00%
Ra-226	3.77E-01	4.83E+05	2.04E+01	7.81E-07	1.85E-02	0.00%	0.08%
Ra-228	1.23E-10	NA	1.97E+05	NA	6.24E-16	NA	0.00%
Rh-103m	2.23E-58	1.71E+06	3.78E+06	1.30E-64	5.90E-65	0.00%	0.00%
Rh-106	9.25E-03	1.62E+04	1.33E+03	5.71E-07	6.95E-06	0.00%	0.00%
Rn-220	4.45E-04	5.36E+06	1.55E+01	8.30E-11	2.87E-05	0.00%	0.00%
Rn-222	4.97E-06	7.20E+07	1.78E+01	6.90E-14	2.79E-07	0.00%	0.00%
Ru-103	1.63E-29	6.38E+03	9.23E+03	2.55E-33	1.77E-33	0.00%	0.00%
Ru-106	9.93E-03	NA	1.94E+05	NA	5.12E-08	NA	0.00%
Sb-124	1.68E-40	1.65E+03	1.38E+03	1.02E-43	1.22E-43	0.00%	0.00%
Sb-125	7.53E+00	7.12E+03	6.02E+03	1.06E-03	1.25E-03	0.01%	0.01%
Sc-46	2.23E-20	1.47E+03	2.73E+03	1.52E-23	8.17E-24	0.00%	0.00%
Sm-147	3.25E-06	NA	4.34E+01	NA	7.49E-08	NA	0.00%
Sn-119m	1.20E-07	7.65E+05	1.69E+06	1.57E-13	7.10E-14	0.00%	0.00%
Sr-89	4.79E-44	1.62E+07	3.34E+03	2.96E-51	1.43E-47	0.00%	0.00%
Sr-90	1.88E+04	NA	3.34E+03	NA	5.63E+00	NA	23.11%
Tc-99	4.62E+00	2.36E+04	1.60E+04	1.96E-04	2.89E-04	0.00%	0.00%

Table 13. (continued).

COPC	Maximum Concentration from EDF-ER-264 (pCi/g)	External Dose EBSL	Internal Dose EBSL	SLQ for External	SLQ for Internal	%External[b]	%Internal[b]
Te-125m	1.88E+00	8.42E+04	1.86E+05	2.23E-05	1.01E-05	0.00%	0.00%
Th-228	2.74E-02	1.51E+06	1.81E+01	1.81E-08	1.51E-03	0.00%	0.01%
Th-229	4.11E-08	7.15E+04	3.60E+01	5.75E-13	1.14E-09	0.00%	0.00%
Th-230	1.40E-01	7.76E+06	2.09E+01	1.80E-08	6.70E-03	0.00%	0.03%
Th-231	1.30E-01	1.63E+05	2.33E+04	7.98E-07	5.58E-06	0.00%	0.00%
Th-232	1.27E-01	1.81E+07	2.43E+01	7.02E-09	5.23E-03	0.00%	0.02%
Th-234	1.39E-03	3.66E+05	4.16E+04	3.80E-09	3.34E-08	0.00%	0.00%
Tm-170	5.14E-26	1.07E+06	6.17E+03	4.80E-32	8.33E-30	0.00%	0.00%
U-232	4.28E-04	1.66E+06	1.54E+01	2.58E-10	2.78E-05	0.00%	0.00%
U-233	2.05E-05	1.02E+07	2.03E+01	2.01E-12	1.01E-06	0.00%	0.00%
U-234	4.97E+00	2.01E+06	2.05E+01	2.47E-06	2.42E-01	0.00%	1.00%
U-235	8.90E-02	2.16E+04	2.27E+01	4.12E-06	3.92E-03	0.00%	0.02%
U-236	1.64E-01	2.15E+06	2.17E+01	7.63E-08	7.56E-03	0.00%	0.03%
U-238	1.58E+00	2.44E+06	2.32E+01	6.48E-07	6.81E-02	0.00%	0.28%
U-240	2.05E-11	4.39E+05	1.54E+04	4.67E-17	1.33E-15	0.00%	0.00%
Xe-131m	2.23E-112	1.47E+05	3.23E+05	1.52E-117	6.90E-118	0.00%	0.00%
Y-90	1.88E+04	4.68E+03[a]	1.74E+03[a]	NA	NA	NA	NA
Zn-65	2.23E-09	5.21E+03	1.13E+04	4.28E-13	1.97E-13	0.00%	0.00%
Zr-93	7.02E-01	NA	9.95E+04	NA	7.06E-06	NA	0.00%
Zr-95	2.40E-25	3.69E+03	5.49E+03	6.50E-29	4.37E-29	0.00%	0.00%
Total SLQ				8.75E+00	2.44E+01	100.00%	100.00%

a. Eliminated from consideration due to the extremely short half life (Miller, R. E., BBWI, conversation with S. W. Perry, BBWI, August 15, 2001, "Radiological information.").

b. % values for avian or mammalian are the SLQ for each COPC divided by the total SLQ

Note: Highlighting of a value indicates that the COPC was retained for further evaluation.

Table 14 presents the results of the analysis for radionuclides identified in the leachate, sediment, and soil. None of the three radionuclides detected in both the leachate and soil exceeds the standards criteria. However, for future monitoring of this facility, it is important to note that the use of concentration data from co-located surface water and sediment samples is preferred and will result in a less conservative, more realistic evaluation.

Table 14. Results of the analysis for radionuclides identified in the leachate, sediment, and soil.

	Aquatic System					
	Leachate Concentration (pCi/L)	BCG[a] (water) (pCi/L)	Ratio (water)	Sediment Concentration (pCi/g)	BCG (sediment) (pCi/g)	Ratio (sediment)
I-129	3.4E+03	2.7E+04	0.126	NA	NA	NA
Tc-99	6.75E+03	5.40E+05	0.013	NA	NA	NA
U-238	8.64E+00	2.16E+02	0.040	NA	NA	NA
Sum of ratios			0.179			NA
	Terrestrial System					
	Leachate Concentration (pCi/L)	BCG (water) (pCi/L)	Ratio (water)	Soil Concentration (pCi/g)	BCG (soil) (pCi/g)	Ratio (soil)
I-129	3.4E+03	5.4E+06	0.001	1.04E+00	6.E+03	0.000
Tc-99	6.75E+03	3.42E+06	0.000	9.62E+00	4.E+03	0.002
U-238	8.64E+00	5.4E+05	0.000	1.58E+00	2.E+03	0.001
Sum of ratios			0.001			0.003

a. BCG = Biotic Concentration Guides.

3.2 Uncertainty Associated with Ecologically Based Screening Levels

3.2.1 Uncertainty Associated with Functional Groups

The selection of receptor parameters used is designed to ensure that each of the members of the functional groups is conservatively represented. Since all members of a functional group are considered similar, it is reasonable to assume that all members of a group will be equally exposed to site-related contaminants. Quantification of dose for each functional group is expected to provide sufficient data to assess the general condition of the ecosystem and to be adequately protective of the majority of species potentially inhabiting the assessment area. In addition, sensitive species are included on the list of receptors for which dose is calculated. Hence, uncertainty associated with the selection of receptor parameters is expected to minimally influence dose estimates.

3.2.2 Uncertainty Associated with the Ingestion Rate

Terrestrial receptor intake (ingestion) rates are based upon data in the scientific literature, when available. Food IRs are mostly calculated by use of allometric equations reported in Nagy (1987). Uncertainties associated with the use of allometric equations could result in either an overestimation or underestimation of the true dose rate, since actual IRs are known for few species.

3.2.3 Uncertainty Associated with the Receptor Site Usage

The calculation of dose incorporated the probability that the receptors may use or inhabit each site. The SUF is defined as the affected area (ha) divided by the home range (ha) of the receptor. If a given receptor's home range is larger than the affected area, then it is reasonable to assume that the receptor may not spend 100% of its life within the site area. Incorporation of the SUF adjusts the dose to account for the estimated time the receptor spends on the site. The less time spent on the site, the lower the dose. However, most home ranges are estimated from available literature values and allometric equations. Home range and usage of areas also vary from season to season as well as year to year (depending on the species of interest), and are difficult to measure (this uncertainty could result in either an overestimation or underestimation of the true dose rates).

3.2.4 Uncertainty Associated with the PUFs and BAFs

There is a great deal of uncertainty associated with the BAFs used to calculate dose. Very few BAFs are available in the scientific literature, since they must be both contaminant- and receptor-specific. In the absence of specific BAFs, a value of 1 was assumed. This assumption could over- or underestimate the true dose from the contaminant, and the magnitude of error cannot be quantified. Travis and Arms (1988) and Baes et al. (1984) report BAFs for contaminants to beef and milk; all of these are less than 1 for the contaminants in the assessment area. If the terrestrial receptors of concern accumulate metals and PCBs in a similar way and to a comparable degree as beef and dairy cattle, the use of a BAF of 1 for all contaminants and receptors would overestimate the dose. On the other hand, if the terrestrial receptors of concern accumulate metals and PCBs to a much larger degree than beef and dairy cattle, the assumption of BAFs equal to 1 could underestimate the true dose from the COPCs.

3.2.5 Uncertainty Associated with Soil Ingestion

The exposure assessment incorporates percentage of soil ingested by each representative of the functional groups. Although food IRs have the greatest effect on intake estimates, soil IRs could also influence intake rates and, therefore, dose estimates. The EPA *Wildlife Exposure Factors Handbook* (EPA 1993) and Beyer, Conner, and Gerould (1994) were used to assign soil ingestion parameters to four of the twelve functional groups, and Arthur and Gates (1988), as noted in Table 9, was used to assign percent soil ingested by two common species (estimating the percent soil ingested may overestimate or underestimate the dose since the effect of the estimated values on the overall dose outcome is dependent on the concentration of contaminant in the media of concern).

3.2.6 Uncertainty Associated with Toxicity Data

The derivation of final TRVs for the various receptors and contaminants typically includes uncertainty factors (UFs) associated with extrapolation from laboratory studies and UFs incorporated to adjust toxicity from lethal doses to chronic doses. There are especially large uncertainties in the plant and soil invertebrate toxicity information since plants and soil organisms can adapt to a wide range of soil conditions. There are other sources of uncertainty that are not addressed using numerical uncertainty factors. For example, that laboratory studies used as a basis for generating TRVs may not accurately represent the complexities of potential exposure under field conditions. For example, the dosing of test animals by use of highly soluble salts in drinking water may over estimate exposures compared to the same salt administered in food. The chemical form present at the site may be in a less soluble form than that used in the laboratory study. In addition, some studies used to generate TRVs are not chronic in nature. It is difficult to interpret the potential for long-term ecological effects from acute or subchronic studies. Toxicological studies on which TRVs are based deal with a single chemical; effects of simultaneous exposure to multiple contaminants are not addressed.

TRVs are not available for a number of contaminants and receptors, and an EBSL cannot be calculated. When EBSLs or TRVs are not available it increases the possibility of underestimating risks.

Several of the COPCs and radiological COPCs were eliminated from consideration based on the lack of EBSL information. As is mentioned before, the contaminate concentrations are very conservatively modeled and the elimination of several of these COPCs is not considered to be significant. Risk may be underestimated but not to the point of being a major concern.

4. HAZARD QUOTIENT ANALYSIS

This sections discusses the development of hazard quotients and hazard indices for those COPCs and radiological COPCs that were retained in the screening from Section 4. Individual species were selected for the HQ analysis. These individual receptors were chosen from each of the functional groups assessed in the initial SLERA. The selection of species is documented in Appendix H of the Operable Unit (OU) 10-04 WAG 6 and 10 Comprehensive Remedial Investigation/Feasibility Study (RI/FS) (DOE-ID 2001). This approach is similar to the ERA conducted for the OU 10-04 WAG 6 and 10 Comprehensive RI/FS, and is developed to be more realistic than calculating HQs by functional groups. Table 15 lists the functional groups and the individual species representative for each functional group. The species selected for the HQ analysis include; mourning dove, sage sparrow, ferruginous hawk, loggerhead shrike, burrowing owl, black-billed magpie, mule deer, pygmy rabbit, Townsend's western big-eared bat, deer mouse, coyote, and sagebrush lizard.

Plants were not assessed within this ERA because all vegetation will be removed from the site, and growth during the operational period will be hindered. Specifically, during operation of the landfill, the area where deposition of contaminated soil is occurring will be kept clear of vegetation. Erosion control will be maintained using plants; however, the areas vegetated will be on the sides of the landfill and should not have contact with contaminated soil. Post-operationally, the ICDF landfill will be capped with a robust state-of-the-practice cover with a middle section designed to eliminate biointrusion (burrowing animals) and a capillary break to eliminate root intrusion (EDF-ER-279).

Table 15. Terrestrial ecological receptors and associated functional groups.

Receptor	Functional Groups Represented	Comment	Assessed as a Receptor?
Plants	All vegetation	Also used to represent T/E and species of concern	No[a]
Grasshoppers, beetles	Terrestrial invertebrates	Used to represent all terrestrial invertebrates including insects and all pollinators	No[a]
Great Basin spadefoot toad	Amphibian (A232)	Used to represent all amphibians; lack of toxicity data and exposure parameters restrict evaluation of amphibians to qualitative discussion	No[a]
Sagebrush lizard	Reptilian insectivores (R222)	Inclusion of reptiles is appropriate for a site-wide ERA; more common; used also to represent the gopher snake and other reptiles	Yes
Gopher snake	Reptilian carnivore (R322)	Lack of toxicity data and exposure parameters restrict evaluation of reptiles to qualitative discussion; less common; selected sagebrush lizard to represent all reptiles	No
Pygmy rabbit	Mammalian herbivores (M122A)	Species of concern; used to also represent other rabbits and small ground dwelling or burrowing mammals	Yes
Nuttall's cottontail	Mammalian herbivores (M122A)	Represented by the pygmy rabbit, which is a species of concern	No
Montane vole	Mammalian herbivore (M122A)	Represented by the pygmy rabbit, which is a species of concern	No
Deer mouse	Mammalian omnivores (M422)	Used to represent other small mammalian omnivores and insectivores (e.g., Merriam's shrew)	Yes
Merriam's shrew	Mammalian insectivores (M222)	Represented by the deer mouse, which is an omnivore; therefore, insects as a dietary item are addressed.	No
Mule deer	Mammalian herbivores (M122)	Common; used to represent other large mammalian herbivores (e.g., pronghorn, elk).	Yes
Pronghorn	Mammalian herbivores (M122)	Represented by the mule deer, which is common on the INEEL; pronghorn is also a game species.	No

Table 15. (continued)

Receptor	Functional Groups Represented	Comment	Assessed as a Receptor?
Elk	Mammalian herbivores (M122)	Represented by the mule deer, which is common on the INEEL; elk is also a game species.	No
Coyote	Mammalian carnivores (M322)	Common; also represents long-tailed weasel and other carnivores, including felids	Yes
Long-tailed weasel	Mammalian carnivores (M322)	Represented by the coyote	No
Gray wolf	Mammalian carnivores (M322)	T/E species; rare; represented by the coyote	No
Townsend's western big-eared bat	Mammalian insectivores (M210A)	Species of concern; includes other bats	Yes
Long-eared myotis	Mammalian insectivores (M210)	Represented by Townsend's western big-eared bat	No
Small-footed myotis	Mammalian insectivores (M210A)	Represented by Townsend's western big-eared bat	No
Loggerhead shrike	Avian carnivores (AV322)	Federal C2 candidate species; used to also represent other small carnivorous avian species	Yes
American kestrel	Avian carnivores (AV322)	Represented by the ferruginous hawk	No
Ferruginous hawk	Avian carnivores (AV322)	Federal C2 candidate species; used to also represent the American kestrel, other hawks, eagles, and other small- to medium-size raptors	Yes
Burrowing owl	Avian carnivores (AV322A)	Species of concern; used also to represent other owls	Yes
Mourning dove	Avian herbivores (AV122)	Common; used also to represent other herbivorous passerine birds (e.g., horned lark); receptor is also a game species	Yes
Horned lark	Avian herbivores (AV122)	Represented by the mourning dove	No
Sage grouse	Avian herbivore (AV122)	Represented by the mourning dove, which is also a game species	No
Sage sparrow	Avian insectivores (AV222)	Common; also used to represent other terrestrial avian insectivores	Yes
Red-winged blackbird	Avian insectivores (AV232)	Represented by the sage sparrow; aquatic habitat is limited	No
Barn swallow	Avian insectivore (AV210)	Represented by the sage sparrow	No
Black-billed magpie	Avian omnivores (AV422)	Also used to represent crows, ravens, and other avian omnivores	Yes

a. Note these receptors would normally be assessed, however, were eliminated from this assessment as discussed in the text.

The exposure parameters used in the initial assessment were also modified to better represent the activities at the ICDF. As discussed above, the area will be free from vegetation and as a result exposure to individual receptors through vegetation (in their diets) will no longer be included. The ICDF Complex will be a highly disturbed area during the construction and disposal of the contaminated soil. The work force at the ICDF are expected to work 10 hour days for over 6 months out of the year depending on the weather (April through November). The disturbance in the top layer will discourage most mammalian species from reaching or burrowing into the contaminated soil, and avian species exposure will be nearly eliminated. The ICDF complex will be fenced. While this will not eliminate all species from using the area, it will provide another deterrent to large mammals. Therefore, the exposure duration (ED) for each species was reduced as shown in Table 16 to more realistically reflect the individual receptors potential use of the site. The body weights and home ranges were re-evaluated for each species. The parameters used to calculate the HQs are shown in Table 16 and the concentration factors from feed to tissue for radionuclides are shown in Table 17. The source of the information used in Table 16 is found footnoted at the end of the table.

Table 16. Parameter input values for hazardous index (HI) calculations.

Individual Species	PP	PV	PS	ED[a]	IR (kg/day)[b]	BW (kg)[c]	HR (Ha)	WI (L/day)[b]
Great Basin spadefoot toad[d]	9.41E-01	0.00E+00	5.90E-02	0.00E+00	6.49E-05	8.00E-03	1.24E-01	0.00E+00
Mourning dove[e]	0.00E+00	0.00E+00	1.00E-02	5.00E-01	1.42E-02	1.15E-01	5.48E+03	1.39E-02
Sage sparrow[f]	9.07E-01	0.00E+00	9.30E-02	2.50E-01	4.45E-03	1.93E-02	1.30E+02	4.19E-03
Ferruginous hawk[g]	9.80E-01	0.00E+00	2.00E-02	2.50E-01	6.65E-02	1.23E+00	5.60E+02	6.78E-02
Loggerhead shrike[h]	9.80E-01	0.00E+00	2.00E-02	2.50E-01	7.99E-03	4.74E-02	2.50E+01	7.65E-03
Burrowing owl[i]	9.70E-01	0.00E+00	3.00E-02	1.00E-01	1.76E-02	1.59E-01	2.00E+02	1.72E-02
Black-billed magpie[j]	4.95E-01	0.00E+00	1.00E-02	2.50E-01	1.97E-02	1.89E-01	1.10E+01	1.93E-02
Mule deer[k]	0.00E+00	0.00E+00	2.00E-02	2.50E-01	1.48E+00	4.90E+01	2.43E+02	3.29E+00
Pygmy rabbit[l]	0.00E+00	0.00E+00	2.00E-02	2.50E-01	4.53E-02	4.04E-01	9.00E-02	4.38E-02
Townsend's western big-eared bat[m]	9.90E-01	0.00E+00	1.00E-02	2.50E-01	2.11E-03	9.00E-03	4.93E+03	1.43E-03
Deer mouse[n]	4.90E-01	0.00E+00	2.00E-02	2.50E-01	3.56E-03	2.20E-02	1.00E+00	3.19E-03
Coyote[o]	9.72E-01	0.00E+00	2.80E-02	2.50E-01	5.87E-01	1.36E+01	8.00E+03	1.04E+00
Sagebrush lizard[p]	9.76E-01	0.00E+00	2.40E-02	2.50E-01	3.47E-04	6.61E-03	1.17E-01	9.04E-03

a. Exposure duration reduced to reflect increased activity at the ICDF area.
b. IR and IW are calculated using allometric equations from Nagy (EPA 1993).
c. Avian body weights: Highest mean (for either sex) taken from CRC Handbook of Avian Body Masses (Dunning 1993).
d. Great Basin spadefoot toad body weight from Steenhof (1983).
e. Mourning dove home range (Moore and Dolbeer 1989).
f. Sage sparrow home range (http://rmb.wantjava.com/bcp/phy62/sage/sasp.jsp).
g. Ferruginous hawk home range (McAnnis-Gerhardt 1991).
h. Loggerhead shrike home range (http://www.npwrc.usgs.gov/resource/literatr/grasbird/logger/logger.htm).
i. Burrowing owl home range (http://www.owlpages.com/species/athene/cunicularia/Default.htm).
j. Black-billed magpie home range (http://imnh.isu.edu/digitalatlas/).
k. Mule deer home range and body weight (http://imnh.isu.edu/digitalatlas/).
l. Pygmy rabbit body weight (Arthur and Markham 1978) (mean adult) and home range (http://www.sibr.com/mammals/M044.html).
m. Townsend's western big-eared bat (Fitzgerald, Meaney, and Armstrong 1994).
n. Deer mouse home range and body weight (http://imnh.isu.edu/digitalatlas/).
p. Sagebrush lizard home range (Guyer 1978); body weight (Burkholder 1973) (mean adult).
o. Coyote home range and body weight (http://imnh.isu.edu/digitalatlas/).

Table 17. Concentration factors for radionuclides for hazard index (HI) calculations.[a]

Functional Groups	Am-241	Cs-137	Eu-152	Eu-154	Pu-238	Pu-239	Sr-90	Kr-85
Great Basin spadefoot toad	5.5E-03	2.0E-02	1.0E-02	1.0E-02	4.5E-04	4.5E-04	3.0E-04	1.0E+00
Mourning dove	5.5E-03	2.0E-02	1.0E-02	1.0E-02	4.5E-04	4.5E-04	3.0E-04	1.0E+00
Sage sparrow	5.5E-03	2.0E-02	1.0E-02	1.0E-02	4.5E-04	4.5E-04	3.0E-04	1.0E+00
Ferruginous hawk	5.5E-03	2.0E-02	1.0E-02	1.0E-02	4.5E-04	4.5E-04	3.0E-04	1.0E+00
Loggerhead shrike	5.5E-03	2.0E-02	1.0E-02	1.0E-02	4.5E-04	4.5E-04	3.0E-04	1.0E+00
Burrowing owl	5.5E-03	2.0E-02	1.0E-02	1.0E-02	4.5E-04	4.5E-04	3.0E-04	1.0E+00
Black-billed magpie	5.5E-03	2.0E-02	1.0E-02	1.0E-02	4.5E-04	4.5E-04	3.0E-04	1.0E+00
Mule deer	5.5E-03	2.0E-02	1.0E-02	1.0E-02	4.5E-04	4.5E-04	3.0E-04	1.0E+00
Pygmy rabbit	5.5E-03	2.0E-02	1.0E-02	1.0E-02	4.5E-04	4.5E-04	3.0E-04	1.0E+00
Townsend's western big-eared bat	5.5E-03	2.0E-02	1.0E-02	1.0E-02	4.5E-04	4.5E-04	3.0E-04	1.0E+00
Deer mouse	5.5E-03	2.0E-02	1.0E-02	1.0E-02	4.5E-04	4.5E-04	3.0E-04	1.0E+00
Coyote	5.5E-03	2.0E-02	1.0E-02	1.0E-02	4.5E-04	4.5E-04	3.0E-04	1.0E+00
Sagebrush lizard	5.5E-03	2.0E-02	1.0E-02	1.0E-02	4.5E-04	4.5E-04	3.0E-04	1.0E+00

a. Concentration factors taken from OU 10-04 Work Plan (DOE-ID 1999) with the following exception: Cs taken from Baes et al. (1984) as supported by specific sampling results.

5. RISK ESTIMATE

The final level of screening was an analysis of hazard quotients (HQs) and hazard indices (HIs). Risk was estimated by the evaluation of dose from modeled concentrations of contaminants planned for disposal at the ICDF to TRVs. Concentrations used in this SLERA were developed from the Design Inventory (EDF-ER-264) and the CWID report, as discussed previously. Concentrations were calculated based upon an agreed method (Section 1.1.1) of assuming the contaminant mass evenly distributed throughout the entire volume.

If the dose from the contaminant does not exceed its target value (i.e., if the HI is less than 10 for nonradiological contaminants and 1.0 for radiological contaminants), adverse effects to ecological receptors from exposure to that contaminant are not expected. Hence, the HIs are calculated from the HQs and are an indicator of potential risk. HQs are calculated using the following equation:

$$HQ = \frac{Dose}{TRV} \tag{26}$$

where

HQ = hazard quotient (unitless)

$Dose$ = dose from all media (mg/kg/day or pCi/g/day)

TRV = toxicity reference value (mg/kg/day or pCi/g/day).

If information was not available to derive a TRV, then an HQ could not be developed for that particular contaminant and species combination.

For each group of contaminants by receptor the HQs will be summed to produce a total HI. This will then used to evaluate the cumulative risk to receptors from COPCs concentrations modeled to be present using similar criteria as the HQ analysis. It is important to consider additive effects from all COPCs for each receptor or receptor group. A HI greater than the target value would imply a possible effect to a receptor from all contaminants combined.

The advantages of using a HI approach is that it allows the summation of effects and the determination of relative risk from a suite of contaminants under consideration. The disadvantages of this approach is that it assumes that effects from contaminants are additive. It is more likely that some effects will be additive and still other effects may be synergistic (either positively or negatively). Little is known about synergism of contaminant effects. Strictly speaking, summing may only be appropriate when the contaminants have equivalent effects. Effects from the nonradioactive metals and organics are expected to cause systemic toxicity (although some are also carcinogens), while the effect associated with exposure to ionizing radiation is typically cancer. This may also be true of other classes of contaminants. The correct usage of any quotient method is highly dependent on professional judgment, particularly in instances when the quotient approaches the risk target. The effects of the uncertainty inherent in the HI should be discussed.

All organic and inorganic COPCs were analyzed for their cumulative effect on receptors. A HQ/HI evaluation was performed to ensure that inorganic and organic COPCs contributing to accumulated risk were considered. Table B-1 in Appendix B presents the results of HQ/HI analysis for the inorganic and organic COPCs contributing to accumulated risk.

All radiological COPCs were analyzed for their cumulative effect on receptors. A HQ/HI evaluation was performed to insure that radiological COPCs contributing to accumulated risk were considered. Table B-2 in Appendix B presents the results of HQ analysis for the aforementioned radiological COPCs contributing to accumulated risk.

The contaminants retained for evaluation in the ecological risk assessment (ERA) from the soil at the ICDF landfill include: acetone, aroclor-1254, boron, copper, cyanide, fluoride, lead, mercury (inorganic), molybdenum, nitrate, pentachlorophenol, selenium, silver, strontium, sulfate, xylene, zinc, zirconium, Am-241, Cs-137, Eu-152, Eu-154, Pu-238, Pu-239, Sr-90, Kr-85. Ten additional contaminants (as leachates) were evaluated for ecological risk from water concentrations in the evaporation ponds (see Appendix A). These contaminants may have been eliminated in the initial soil screening, but have been retained in the ERA for further evaluation because of possible ecological risk from concentrations in the water from the evaporation ponds. These include arsenic, boron, calcium, chlorine, magnesium, potassium, selenium, sulfate, vanadium, and zinc. Chlorine could not be assessed because of the lack of toxicity data to develop toxicity reference values. The Leachate/Contaminant Reduction Time Study (EDF-ER-274) included all constituents existing in solution as anions (this includes chlorine). Geochemical modeling was used to develop concentrations of the element in the leachate. EDF-ER-274 states that the modeled leachate is a brackish to saline water dominated by sodium and sulfate with a pH of 8.2. Chlorine is a strong oxidizer that will react rapidly with inorganic compounds in water. Given this environment and the reactivity it is assumed that chlorine will exist as sodium chloride (or another dissolved salt) in the leachate. Given that the leachate will be diluted by make up water and based on studies presented in the Mineral Tolerance of Domestic Animals (NAS 1980) (indicating that very high levels of sodium chloride can be tolerated) chlorine will not be further evaluated.

5.1 Risk Estimates for Inorganic and Organic Contaminants

The results of the HQ/HI assessment for inorganic and organic contaminants is presented in Appendix B. All contaminants were eliminated in the HQ and HI calculations, because no individual receptor had HIs greater than 10 and most were below an HI of 1.0.

5.2 Risk Estimates for Radiological Contaminants

The results of the HQ/HI assessment for external and internal exposure to radionuclides at the ICDF Complex are presented in Appendix B. Receptor groups with HIs above 1.0 and the contributing radiological contaminates are discussed below. Those groups with HIs below 1.0 are considered to contribute limited risk and do not require further evaluation. Those COPCs adding to cumulative risk were included in the discussion. The COPC adding the most to cumulative risk and its percent of the total HI is indicated in parenthesis.

5.3 External Exposure to Radionuclides

All contaminants were eliminated in the HQ calculations, because no individual receptor had HQs greater than 1.0.

5.4 Internal Exposure to Radionuclides

Kr-85 was the only radionuclide with HQs greater than or equal to 1.0 for internal exposure (no other radionuclides had HQs greater than 1.0). This radionuclide is a chemically inert gas that was conservatively assumed to be present in the inventory. However, it is highly unlikely that it will be present in the soil at the concentrations modeled due to its volatility. Additionally, Kr-85 has no concentration factor for feed to tissue uptake to develop a realistic exposure assessment, since it is a gas and mainly presents an inhalation risk. Also, the half life for this radionuclide is 10.8 years and it is not anticipated to remain at the concentrations modeled throughout the life time of the ICDF. It is considered to presents minimal risk and is not considered a hazard to ecological receptors. The receptors and an analysis of the HIs with and without Kr-85 is presented below.

- Pygmy rabbit: Kr-85 was the major contributor to the total HI for this species (1.4); if Kr-85 is eliminated the total HI would then be 0.2 with the major contributor being Cs-137.

- Deer mouse: Kr-85 was the major contributor to the total HI for this species (1.4); if Kr-85 is eliminated the total HI would then be 0.2 with the major contributor being Cs-137.

- Sagebrush lizard: Kr-85 was the major contributor to the total HI for this species (1.4); if Kr-85 is eliminated the total HI would then be 0.2 with the major contributor being Cs-137.

6. DEVELOPMENT OF ACCEPTABLE LEACHATE CONCENTRATIONS

Due to the uncertainty associated with the masses and the subsequent modeling of the leachate concentration, acceptable leachate concentrations (ALCs) for use at the ICDF were developed for those COPCs identified in the Leachate/Contaminant Reduction Time Study (EDF-ER-274). Radiological COPCs should be evaluated using the proposed standard A Graded Approach for Evaluating Radiation Doses to Aquatic and Terrestrial Biota (DOE, in preparation). It is approved by EH-4 for interim use by DOE program and field elements in evaluating doses to biota. This technical standard provides dose evaluation methods that can be used to meet the requirements of DOE Orders 5400.1 and 5400.5.

The leachate is considered the major pathway of exposure to ecological receptors since the soil exposure will be limited by the 2-ft clean fill layer maintained during facility operations and the biobarrier that will be in place with the facility is completed. These ALCs can then be used to calculate the acceptable mass using the approach documented in EDF-ER-274.

The approach is based on EPA (1999) and is considered less conservative since it more completely models the food web than the EBSL and HQ analysis documented in VanHorn, Hampton, and Morris (1995) that was primarily used in this analysis. It is presented in Appendix A. In this approach, species were selected as receptors were chosen to evaluate the pathways presenting the most likely route of exposure from potential contaminants at the ICDF leach pond. Both terrestrial and aquatic receptors were selected since the leach pond will be used by waterfowl. However aquatic organisms, such as fish and other benthic organisms, were not assessed since this facility is not considered a natural water body. After the ICDF mission (estimated 15 years) is accomplished the pond will be eliminated as a source of drinking water for those species present at the INEEL. The deer mouse, mule deer, coyote, Townsend's western big-eared bat, mourning dove, sage grouse, red-tailed hawk, and bald eagle were selected as terrestrial receptors. The mallard duck and spotted sandpiper are included as aquatic receptors for assessment at the ICDF leach pond. These species although modeled as having a limited use of the facility are the risk drivers due to the exposure from aquatic sources.

They are included based on the results of the following observational study. Cieminski (1993) studied wildlife use of wastewater ponds at the INEEL. In general, she found that ponds which are large, nutrient-rich, heavily vegetated, and have a low shoreline slope are predicted to have higher wildlife use than ponds which are small, nutrient-poor, and have bare, steep shorelines (Cieminski 1993). She goes on to suggest that sanitary waste ponds, or other ponds which pose negligible health risks to wildlife could be maintained in the former state and toxic ponds in the latter.

Cieminski (1993) evaluated many of the ponds at the INEEL, however, specifically, she evaluated the INTEC percolation ponds. These ponds are most likely to be similar to the ICDF leach pond under construction. Most use of these ponds was by migrating waterfowl, and with one exception (green-winged teal in 1991), no birds are known to nest at the site. The large open ponds were attractive to migrating waterfowl, but the bare shorelines were not attractive to passerines. More species use occurred at these ponds when the water level was low, creating vegetated gravel bars. This is unlikely to occur with the ICDF pond design. The sewage ponds at INTEC also provide a more attractive alternative pond for use, particularly for shorebirds. Raptors were found to visit the ponds less frequently than any other avian group.

Another study found that the residence time of ducks on wastewater ponds was less than 48 hours (Browers and Flake 1983). Due to this information the exposure period for the mallard, spotted sandpiper and bald eagle were significantly reduce. It was assumed that these species would feed for a week totally from the foodweb present at the ICDF pond for 1 week. Therefore the area use factor was reduced to 0.02.

The suspected contaminants were taken from the proposed inventory of contaminants to be disposed of in the landfill. The suspected leachate contaminants included; arsenic, boron, calcium, chlorine, magnesium, phosphorus, potassium, selenium, sulfur, vanadium, and zinc. Calcium, magnesium, and potassium were eliminated from the list of COPCs because these chemicals are essential nutrients and are not considered toxic unless present in extremely high concentrations (10X background values). Chlorine was also eliminated as a COPC because chlorine is a strong oxidizer and will react rapidly with inorganic compounds. The presence of light will also accelerate the dissipation of chlorine in water (Vulcan chemicals). Therefore, chlorine is not likely to remain in the pond for a long period of time.

For the remaining COPCs, ALCs were back calculated from the hazard quotient (of 1.0) to present the allowable leachate concentrations that maybe present in the leach pond. These calculated ALCs are presented in Table 18 (taken from Table A-1) along with the ambient water concentrations and sediment quality concentrations. Results of this analysis are presented in Appendix A.

Table 18. Acceptable leachate concentrations for use at the ICDF.

COPC	ALC (mg/L)	Modeled Leachate Concentrations (mg/L)	Ambient Water Criteria (ug/L)	Sediment Quality Criteria (ppb dry weight)
Arsenic	6	1.53	340	5,900
Boron	—[a]	40.7	—	—
Calcium	—[b]	4.86	—	—
Chlorine	—[c]	16.6	19	—
Magnesium	—[b]	0.25	—	—
Phosphorus	—[d]	6.8	—	—
Potassium	—[b]	0.089	—	—
Selenium	0.07	0.073	5.0 (13-186)	290
Sulfur	—[c, d]	373	—	—
Vanadium	3	3.48	—	50,000
Zinc	8	0.031	120	123,100

a. Boron has no toxicity for aquatic and no AWQC.

b. Toxicity reference values are not available to establish an ALC for calcium, magnesium, or potassium. However, these COPCs are essential nutrients, and are not considered toxic expected under extremely high concentrations (10X background).

c. A soil-water partition coefficient (Kd) value was not available for chlorine or sulfur so an ALC could not be calculated.

d. Toxicity reference values were not available for establishing an ALCs for phosphorus or sulfur.

NOTE: — = no information available.

7. QUALITATIVE DISCUSSION OF EXPOSURE TO SPECIES OF SPECIAL CONCERN

Federal status is the only driver for evaluating a species for risk to the individual. For ecological risk assessment purposes at the ICDF a group of selected species presented in Table 15, were evaluated for exposure. This is a typical risk assessment approach. For the ICDF assessment a listing of all species identified on federal, state, BLM and USFS lists were presented in Table 5. This section will individually qualitatively discuss the species presented in this table and any possible exposure.

Of the 11 plants that are listed in Table 5 only one has federal status as Listed Threatened (LT). This is the Ute ladies' tresses which has no documented sighting on the INEEL. These plants were included in Table 5 for completeness since the ranges of these species overlaps the INEEL and are included as possibilities to be considered for field surveys. The required habitat for these species was not found in the area (DOE-ID 2001) and it is not anticipated that any sensitive species will be found. Plants will be discouraged from growing in the ICDF area except for erosion control. Erosion control will be maintained using plants; however, the areas vegetated will be outside the landfill and should not have contact with contaminated soil.

Of the 20 birds listed in Table 5 only the bald eagle is listed threatened (LT). This species has been assessed on an individual level at many of the sites. The bald eagle is a migratory species and is not present year round at the facility as is discussed below.

Of the mammals listed only the wolf is federally listed as an endangered/experimental population (LE/XN). Anecdotal evidence indicates that isolated wolves may occur on the INEEL. However, no information exists to substantiate hunting or breeding onsite (Morris 1998). Currently, they are under consideration for delisting.

Of the 3 reptiles and amphibians, 1 insect, and 1 fish listed in Table 5, none are federal listed.

However, understanding the importance of these species, biological surveys were performed to identify WAG sites that may have habitat to support these species. Appendix H7 of the OU 10-04 Comprehensive RI/FS (DOE-ID 2001) contains the results of the biological field surveys performed for 20 species of concern including bald eagle, burrowing owl, peregrine falcon, trumpeter swan, back tern, white-faced ibis, ferruginous hawk, northern goshawk, loggerhead shrike, gray wolf, Merriam's shrew, Townsend's western big-eared bat, long-eared myotis, small-footed myotis, northern sagebrush lizard, lemhi milkvetch, plains milkvetch, winged-see evening primrose, spreading gilia.

The burrowing owl habitat survey was conducted as part of the OU 10-04 ecological risk assessment (DOE-ID 2001). In the INTEC area, no optimal habitat for burrowing owl reproduction was located within 200 m of the perimeter fences. During the habitat surveys, no signs of burrowing owl (dropping, pellets, etc.) were seen. The one recorded sighting (in 1985) was approximately 600 m from the perimeter. Therefore, burrowing owls are not anticipated to utilize this area.

Raptors were also evaluated during this survey (DOE-ID 2001). An active ferruginous hawk nest within 6 km of INTEC was observed during 1991-1993. However, it has not been used since. Although perching and feeding area do occur in the INTEC area, for both ferruginous hawk and bald eagles, nesting in the area is unlikely. Additionally, ferruginous hawks tend to avoid areas frequented by humans. The use of these areas will be minimal due to disturbance and seasonal presence.

There is no appropriate pygmy rabbit habitat in the area approximately 250 m around the INTEC fence and no pygmy rabbit sign was found (DOE-ID 2001).

Bats have been seen in the area and use of any ponds in the area should be expected (DOE-ID 2001).

The sagebrush lizard has been sighted in the area. However, the quality of the habitat is spotty. The disturbance in the area surrounding the ICDF should significantly reduce any use of this area. Sagebrush lizard prefer rock outcrops (which do not exist in the area) and would be found primarily in the undisturbed sagebrush areas along the north and west side of the INTEC facility (DOE-ID 2001).

A study by K. Cieminski, was conducted at several INEEL wastewater ponds to determine the type and amount of wildlife potentially being exposed from use of the ponds (Cieminski 1993). In this study, she discovered that the most common species using the wastewater ponds were; mallard, gadwall, green-winged teal, wigeon, northern shoveler, ruddy duck, redhead, American coot, killdeer, spotted sandpiper, Wilson's phalarope, mourning dove, common nighthawk, horned lark, bank swallow, barn swallow, European starling, yellow-headed blackbird, Brewer's blackbird, and the brown-headed cowbird. The months with the greatest activity include May and September. The wastewater pond at the ICDF will be a disturbed area and work activities will be carried out through all of the summer months (April through November). Of the INEEL sensitive bird species, the burrowing owl and bald eagle were rarely sighted at the wastewater ponds. Few large mammals, including the mule deer, were seen at the wastewater ponds; however, the ICDF complex will be enclosed by a fence. While this will not eliminate all species from using the area, it will provide another deterrent to large mammals. No vegetation will be present within the ICDF complex further reducing the amount of herbivores visiting the area.

The Cieminski study also showed that there was no apparent relationship between the number of small mammals captured and distance of the trap from the pond. It is apparent that ponds are not a significant attractant to small mammals. The pygmy rabbit was not sighted at wastewater ponds. Use of wastewater ponds by bats extended from late May through late September, but the majority of observations were in June and July. Bat observations fell between 2000 hours and 0545 hours, but 74% of the observations were between 2200 hours and 0200 hours (Cieminski 1993).

In addition to the number of sighting of receptors the Cieminski study also evaluated the pond characteristics that were more or less favorable to wildlife. Table 19 lists characteristics to be considered in management of wastewater ponds, in order of importance.

Table 19. Pond characteristics to discourage or encourage wildlife use of constructed ponds, listed in order of importance (Cieminski 1993).

	Effect on Wildlife Use	
Characteristic	Discourage	Encourage
Surface area	Minimize	Maximize
Invertebrates	Minimize	Maximize
Shrub cover	None	Maximize
Bare shoreline	(species dependent)[a]	
Shoreline slope	Steep	Low
Shoreline length	Minimize	Maximize
Emergent vegetation	No	Yes
Fencing	Yes	No
Height of berms	High	Low
Length orientation	NW-SE	SW-NE

a. Bare shoreline discourages use by ruddy ducks, American coots, Brewer's sparrows, white-crowned sparrows, and chipping sparrows, and encourages use by spotted sandpipers, Wilson's phalaropes, western sandpipers, and Brewer's blackbirds.

8. ICDF SLERA SUMMARY AND RESULTS

An evaluation of modeled concentrations of contaminants planned for disposal at the ICDF based on EBSLs and HQ/HIs was performed. As discussed, the concentrations used in this SLERA were from the Design Inventory (EDF-ER-264) and/or the CWID (DOE-ID 2000). The Design Inventory contaminant masses were very conservatively modeled and primarily developed to support design of the facility. As discussed in the uncertainty section, some estimated masses were included in the Design Inventory to provide a conservative overestimate. The Design Inventory (EDF-ER-264) states that it should not be used to approximate actual site conditions. However, it does provide an initial approximation of the wastes that may be disposed of in the ICDF landfill and used to model the leachate concentrations anticipated in the evaporation pond. These values were used in this risk assessment. Actual concentrations that ecological receptors will be exposed to, may be lower (or higher, although that is less likely) than the calculated or modeled concentrations used for this assessment.

This assessment should not be used for any other purpose than to evaluate the ICDF inventory. The approach used to assess exposure to the landfill and the associated leach pond used more realistic assumptions concerning exposure than may be acceptable at other sites or the ICDF when the operational period is over. As is discussed in Section 4, the exposure duration was significantly reduced based on the anticipated activity and disturbance while the ICDF is active. Also, several receptors and pathways were eliminated based on exposure assumptions. For example, risk to plants was not evaluated since plants will not be encouraged to grow at the landfill during the period it is active. However, it did not account for any reduction in exposure from the presence of fences. These types of controls at the facility will again reduce the amount of exposure to many ecological receptors at the landfill and leach pond.

The presence of water in the evaporation pond and other related structures (buildings etc.), may however, encourage use by selected species. As discussed in Section 7, some of these may be considered sensitive and should be monitored. For example, bats and other birds may feed on insects from the pond and higher trophic level avian species (hawks) may use power poles for foraging. As discussed, the ingestion of water was evaluated in conjunction with the exposure evaluated at the landfill. For all contaminants, a modeled concentration anticipated to be in the surface water was evaluated. It is expected to more realistically model the exposure because COPCs and radiological COPCs in the pond should go to equilibrium with the sediment reducing the concentrations. Since the pond is not a natural body of water, no evaluation was conducted for such groups of species as benthic organisms or fish.

As discussed in Section 6, the mallard and spotted sandpiper however, were assessed during the development of ALCs. This is documented in Appendix A. From this analysis, it was determined that the modeled leachacte concentrations for all the COPCs should be acceptable to these two species feeding on the pond for a week. The pond should be maintained (see Section 7) to ensure that conditions do not encourage more than transient use by these species.

Based on the results of this assessment the following conclusions and recommendations can be made:

The ICDF Complex appears to have some potential to provide exposure to ecological receptors (see discussion in Section 7). The risk characterization indicates that sulfate and vanadium concentrations in the evaporation ponds could potentially reach concentration levels of concern to ecological receptors. Therefore it is recommended that

- The top layer be maintained (with some type of stabilizer) during the winter months to limit exposure of the contaminated soil to ecological receptors.

- The pond should be built with bare, steep shorelines and conditions be maintained to limit nutrient enrichment and vegetation.

- Continual monitoring and evaluation during the facility operation be implemented to ensure that the modeling assumptions are correct and that necessary preventive measures are implemented to reduce exposure to ecological receptors. The selected COPCs/radiological COPCs should be taken from the results of the evaluation.

It is also assumed that at a bio-barrier will be placed over the landfill when the operation of the landfill is completed and that the leach pond will be appropriately closed.

9. DISCUSSION OF UNCERTAINTY

9.1 Organic Uncertainty

Organic compounds expected to be present in the waste disposed in the ICDF landfill were identified from Table B2 in the Design Inventory (EDF-ER-264). This table presents a list of organic compounds that have been detected or estimated from the release sites destined for disposal in the ICDF landfill. Concentrations and contaminant masses are based on process knowledge from release sites and are substituted for other sites that had similar processes. Actual concentrations and masses in these sites are most likely overestimated or underestimated causing a more conservative or less conservative evaluation of these compounds. An attempt was made to overestimate due to the purposes of the Design Inventory (EDF-ER-264).

9.2 Inorganic Uncertainty

Inorganic compounds expected to be present in the waste disposed in the ICDF landfill were identified from Table C2 in the Design Inventory (EDF-ER-264). This table presents a list of inorganic compounds that have been detected or estimated from the release sites destined for disposal in the ICDF landfill. Concentrations and contaminant masses are based on process knowledge from release sites and are substituted for other sites that had similar processes. Actual concentrations and masses in these sites are most likely overestimated or underestimated, causing a more conservative or less conservative evaluation of these compounds. An attempt was made to overestimate due to the purposes of the Design Inventory (EDF-ER-264).

9.3 Radionuclide Uncertainty

Analytical data on the following radionuclides were detected at one or more release sites: Ag-108m, Am-241, Ce-144, Co-57, Co-60, Cs-134, Cs-137, Eu-152, Eu-154, Eu-155, I-129, K-40, Np-237, Pu-238, Pu-239, Pu-239/240, Ra-226, Ru-106, Sb-125, Sr-90, Tc-99, Th-228, Th-230, Th-232, H-3, U-234, U-235, U-238.

The remaining radionuclides were calculated using a scaling factor based on Cs-137. This was done based on the likelihood that other radionuclides found in typical reactor operations could be present. Whether or not the radionuclides are actually present and at what amounts is uncertain. EBSL information is present for a portion of the radionuclides but not all of them. Those radionuclides that did not have EBSL information were assessed using the same methodology as the other radionuclides and evaluated qualitatively. K-40 was the only radionuclide detected at the release sites that did not have EBSL information to screen against. It was calculated to be 1.37 pCi/g. K-40 makes up 0.0117% of all potassium occurring in nature. At 1.37 pCi/g, K-40 is probably the naturally occurring amount for this area.[b] Actual concentrations and masses in these sites are most likely overestimated or underestimated, causing a more conservative or less conservative evaluation of these compounds. An attempt was made to overestimate due to the purposes of the Design Inventory (EDF-ER-264).

9.4 Hazard Quotients Uncertainty

An HQ/HI greater than the target value indicates that exposure to a given contaminant; however, the level of concern associated with exposure may not increase linearly as HQ/HI values exceed the target value. Therefore, the HQ values cannot be used to represent a probability or a percentage because an HQ

b. Miller, R. E., BBWI, conversation with S. W. Perry, BBWI, August 15, 2001, "Radiological information."

of 10 does not necessarily indicate that adverse effects are 10 times more likely to occur than an HQ of 1. It is only possible to infer that the greater the HQ, the greater the concern about potential adverse effects to ecological receptors. The HQ equation is unable to account for subsurface contamination and thus surface contamination is treated the same when, in fact, the depth of the contamination makes a difference. Secondly the ICDF will be a highly disturbed area during the 10 years it takes the area to be filled. The habitat will be unfavorable to the species considered. Finally, the use of a biobarrier, once the volume is filled, will increase the depth of the contamination that the HQ equation will not calculate.

The hazard quotient calculation was designed to take into account the activity and disturbance at the ICDF as a deterrent to exposure. However, the estimated concentrations and masses of the contaminants are very conservative. Therefore, the risk evaluation performed in this analysis is necessary highly uncertain.

The ICDF SLERA, by definition, is an approach to assess the potential for risk to ecological receptors from contaminants during interim disposal of waste identified in the Design Inventory (EDF-ER-264). The SLERA incorporates levels of uncertainty that could either overestimate or underestimate the actual risk to these receptors. To compensate for potential uncertainties, the SLERA incorporates various factors that are designed to be conservative rather than result in a conclusion of no indication of risk when actual risk may exist. Regardless, uncertainties exist that could affect the estimation of true risk associated with the assessment area. These are summarized in Table 20.

Principal sources of uncertainty lie within the development of an exposure assessment and toxicity assessment. Uncertainties inherent in the exposure assessment are associated with estimation of receptor IRs, estimation of site usage, and estimation of PUFs and BAFs. Additional uncertainties are associated with the depiction of site characteristics, the determination of the nature and extent of contamination, and the derivation of TRVs. All of these uncertainties are likely to influence risk estimates. This is not an estimate of the risk to ecological receptors when the facility is finally closed without the biobarrier (greater than 10 ft).

The risk drivers tend to be from radionuclide contamination. This is at least in part explained by the determination of toxicity values. For radionuclides, the TRVs are based on effects to populations, while for nonradionuclides, the TRVs are based on effects to individuals. As such, the nonradionuclide toxicity data is in this sense more conservative than the radionuclide toxicity data.

In relation to extrapolations between individuals and populations, it is difficult to accurately predict ecological effects of toxic substances because of the complexity of the ecosystem. Most toxicity information comes from laboratory studies of single contaminant impacts on single species. Hence, there is a great deal of uncertainty in extrapolating controlled laboratory results to complex field situations and from one species to another. Single contaminant studies cannot predict the interactions of multiple contaminants with each other and with the ecosystem. Additionally, interactions of organisms with the ecosystem are complex and not easily predicted.

Few data are available for the invertebrate populations at the INEEL. Invertebrates are important links in dietary exposure for wildlife. There is insufficient ecological and toxicological data to adequately characterize the contaminant effects in the invertebrate component of the ecosystem. Such uncertainty will propagate into some of the other endpoint compartments, in particular those representing mammalian, avian, and reptilian insectivores.

The area used in the HQ calculations was very conservative. A cross section was calculated that encompassed the top layer of the pit when completely filled with the contaminated soil (5.35 hectares). The pit was modeled assuming the receptors would have access to the entire pit when in fact it will be gradually filled over time and the actual area that a receptor would be exposed to would be less than the value used in the HQ calculations.

Table 20. Sources and effects of uncertainties in the ecological risk assessment.

Uncertainty Factor	Effect of Uncertainty (level of magnitude)	Comment
Estimation of IRs (soil and food)	May overestimate or underestimate risk (moderate)	Few intake ingestion estimates used for terrestrial receptors are based on data in the scientific literature (preferably site-specific when available). Food IRs are calculated by using allometric equations available in the literature (Nagy 1987). Soil ingestion values are generally taken from Beyer, Conner, and Gerould (1994) as shown in Table 9. Soil ingestion may be a major pathway of exposure. Assumptions made in extrapolating soil ingestion data from species to species may introduce significant uncertainty into the assessment.
Estimation of bioaccumulation and plant uptake factors and use of default values in calculating PUFs	May overestimate risk and the magnitude of error cannot be quantified (high)	Few BAFs or PUFs are available in the literature that are both contaminant- and receptor-specific. In the absence of more specific information, PUFs and BAFs for metals were obtained from Baes et al. (1984) and other literature sources and for organics from Travis and Arms (1988).
Estimation of toxicity reference values	May overestimate (high) or underestimate (moderate) risk	To compensate for potential uncertainties in the exposure assessment, various adjustment factors are incorporated to extrapolate toxicity from the test organism to other species.
Elimination of COPCs based on the lack of EBSL information	May underestimate (low) risk	COPC inventories were very conservatively modeled. The lack of EBSL information may underestimate the risk to receptors but not significantly.
Use of selected species	May underestimate (low)	Species are selected to reduce the amount of calculations required while representing all species potentially present at the facility.
Use of estimated concentrations and quantities	May overestimate (high) or underestimate (very low)	Contaminant masses in the Design Inventory (EDF-ER-264) were very conservative and were based on facility design.
Use of simplistic or reduced modeling of exposure	May underestimate (mod)	Exposure durations were reduced significantly to account for disturbance in the ICDF area.

Ecotoxicological data is recognized as one of the major uncertainties in SLERA. The TRVs are updated as new information is available. This is an ongoing effort that will continue throughout the SLERA process at the INEEL.

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